Southwest Division
Naval Facilities Engineering Command
Contracts Department
1220 Pacific Highway
San Diego, California 92132-5190

Contract No. N68711-92-D-4670

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

CLEAN II

FINAL PHASE II WORK PLAN FOR THE MPE PILOT STUDY, OU-3 IRP SITE 16, CRASH CREW TRAINING PIT NO. 2 MARINE CORPS AIR STATION EL TORO, CALIFORNIA

CTO-0178/0152
July 2000

Prepared by:

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Stephen Blanchard, RG 6215

Signature: ______________________ Date: 17 JULY 2000
~~John C. Scholfield~~, CTO Leader

01LS.DS

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser 06CC.DG/029
January 8, 2001

Mr. John Broderick
California Regional Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3339

Dear Mr. Broderick:

Enclosures 1 through 3 are submitted for your use in updating the Final Phase II Work Plan MPE Pilot Study, OU-3 IRP Site 16, Crash Crew Training Pit No. 2, Marine Corps Air Station El Toro, California. Please replace the corresponding pages in your copy of the document with the enclosures provided. The text in these pages was amended to indicate that the treated groundwater will be discharged on-site to a storm drain following the substantive requirements in the Regional Water Quality Control Board's (RWQCB's) permit for these types of discharges. The previous text had indicated that the discharges would be conducted under an NPDES permit issued by the RWQCB.

Thank you for your agency's support for the efforts at Site 16. Should you have any questions or comments on the document, please contact Mr. Marc Smits at (619) 532-0793.

Sincerely,

DEAN GOULD
Base Realignment and Closure
Environmental Coordinator
By direction of the Commander

Enclosure: (1) Pages 4-5 and 4-6, Final Phase II Work Plan – MPE Pilot Study, IRP Site 16, MCAS El Toro
(2) Pages 4-11 and 4-12, Final Phase II Work Plan – MPE Pilot Study, IRP Site 16, MCAS El Toro
(3) Pages C-1 and C-2, Attachment C, IDWMP, Final Phase II Work Plan – MPE Pilot Study, IRP Site 16, MCAS El Toro

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SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
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5090
Ser 06CC.DG/029
January 8, 2001

Ms. Nicole Moutoux
U.S. Environmental Protection Agency
Region IX
Mail Code STD-8-2
75 Hawthorne Street
San Francisco, CA 94105-3901

Dear Ms. Moutoux:

Enclosures 1 through 3 are submitted for your use in updating the Final Phase II Work Plan MPE Pilot Study, OU-3 IRP Site 16, Crash Crew Training Pit No. 2, Marine Corps Air Station El Toro, California. Please replace the corresponding pages in your copy of the document with the enclosures provided. The text in these pages was amended to indicate that the treated groundwater will be discharged on-site to a storm drain following the substantive requirements in the Regional Water Quality Control Board's (RWQCB's) permit for these types of discharges. The previous text had indicated that the discharges would be conducted under an NPDES permit issued by the RWQCB.

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DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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5090
Ser 06CC.DG/029
January 8, 2001

Ms. Triss Chesney
California Environmental Protection Agency
Department of Toxic Substances Control
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Cypress, CA 90630-4700

Dear Ms. Chesney:

Enclosures 1 through 3 are submitted for your use in updating the Final Phase II Work Plan MPE Pilot Study, OU-3 IRP Site 16, Crash Crew Training Pit No. 2, Marine Corps Air Station El Toro, California. Please replace the corresponding pages in your copy of the document with the enclosures provided. The text in these pages was amended to indicate that the treated groundwater will be discharged on-site to a storm drain following the substantive requirements in the Regional Water Quality Control Board's (RWQCB's) permit for these types of discharges. The previous text had indicated that the discharges would be conducted under an NPDES permit issued by the RWQCB.

Thank you for your agency's support for the efforts at Site 16. Should you have any questions or comments on the document, please contact Mr. Marc Smits at (619) 532-0793.

Sincerely,

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Environmental Coordinator
By direction of the Commander

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(3) Pages C-1 and C-2, Attachment C, IDWMP, Final Phase II Work Plan – MPE Pilot Study, IRP Site 16, MCAS El Toro

5090
Ser 06CC.DG/029
January 8, 2001

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BECHTEL NATIONAL INC.

CLEAN II TRANSMITTAL/DELIVERABLE RECEIPT

Contract No. N-68711-92-D-4670 **Document Control No.:** CTO-0178/0152

File Code: 0202

TO: Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 02R1
1220 Pacific Highway
San Diego, CA. 92132-5190

DATE: July 28, 2000
CTO #: 0178
LOCATION: MCAS El Toro

FROM:
Thurman L. Heironimus, Project Manager

DESCRIPTION: Final Phase II Work Plan for the MPE Pilot Study, Operable Unit – 3, IRP Site 16 Crash Crew Training Pit No. 2 - Dated July 2000

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Bechtel Job No. 22214
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File Code: 0202

IN REPLY REFERENCE: CTO-0178/0152

July 28, 2000

Contracting Officer
Naval Facilities Engineering Command
Southwest Division
Mr. Richard Selby, Code 02R1
1220 Pacific Highway
San Diego, CA 92132-5190

Subject: Final Phase II Work Plan for the MPE Pilot Study, Operable Unit – 3, IRP Site 16 Crash Crew Training Pit No. 2, MCAS El Toro, California - Dated July 2000

Dear Mr. Selby:

It is our pleasure to submit these copies of Final Phase II Work Plan for the MPE Pilot Study, Operable Unit – 3, IRP Site 16 Crash Crew Training Pit No. 2, Marine Corps Air Station, El Toro, California, prepared under Contract Task Order (CTO) 0178 and Contract No. N68711-92-D-4670. We gratefully acknowledge the high level of cooperation and team work demonstrated by personnel from Southwest Division in preparation of these documents.

We appreciate the opportunity to be of service to you on this project. If you have any questions or would like further information, please contact John Scholfield, CTOL, at (619) 744-3093 or me at (619) 744-3004.

Sincerely,

Thurman L. Heironimus, R.G.
Project Manager

TLH/sp

Enclosures: Final Phase II Work Plan for the MPE Pilot Study, Operable Unit – 3, IRP Site16 Crash Crew Training Pit No. 2, MCAS El Toro, California - Dated July 2000

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ATTACHMENTS

FIGURES

TABLES

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ACRONYMS/ABBREVIATIONS

ARCH	air rotary casing hammer
ASTM	American Society for Testing and Materials
BCT	BRAC Cleanup Team
bgs	below ground surface
BNI	Bechtel National, Inc.
BOD	biological oxygen demand
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	chemical of concern
CPT	cone penetrometer test
CTO	contract task order
DCA	dichloroethane
DCE	dichloroethene
DMP	Data Management Plan
DON	Department of the Navy
DQO	data quality objective
FID	flame ionization detector
FS	feasibility study
FSP	field sampling plan
GAC	granular activated carbon
gpm	gallons per minute
IDW	investigation-derived waste
IDWMP	investigation-derived waste management plan
IRP	Installation Restoration Program
JEG	Jacobs Engineering Group
JP-5	jet propellant – Grade 5
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
MPE	multiphase extraction

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PID	photoionization detector
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RAO	remedial action objective
RI	remedial investigation
ROI	radius of influence
RWQCB	(California) Regional Water Quality Control Board
SCAQMD	South Coast Air Quality Management District
SOP	standard operating procedure
SSHP	Site-Specific Safety and Health Plan
STLC	solubility threshold limit concentration
SVE	soil vapor extraction
SVM	soil vapor monitoring
SVOC	semivolatile organic compound
SWDIV	Southwest Division Naval Facilities Engineering Command
TAL	target analyte list
TCE	trichloroethene
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
VGAC	vapor-phase granular activated carbon
VOA	volatile organic analyte
VOC	volatile organic compound
WHPA	(U.S. EPA) Wellhead Protection Analysis (Program)
WIP	Well Investigation Program

Section 1
INTRODUCTION

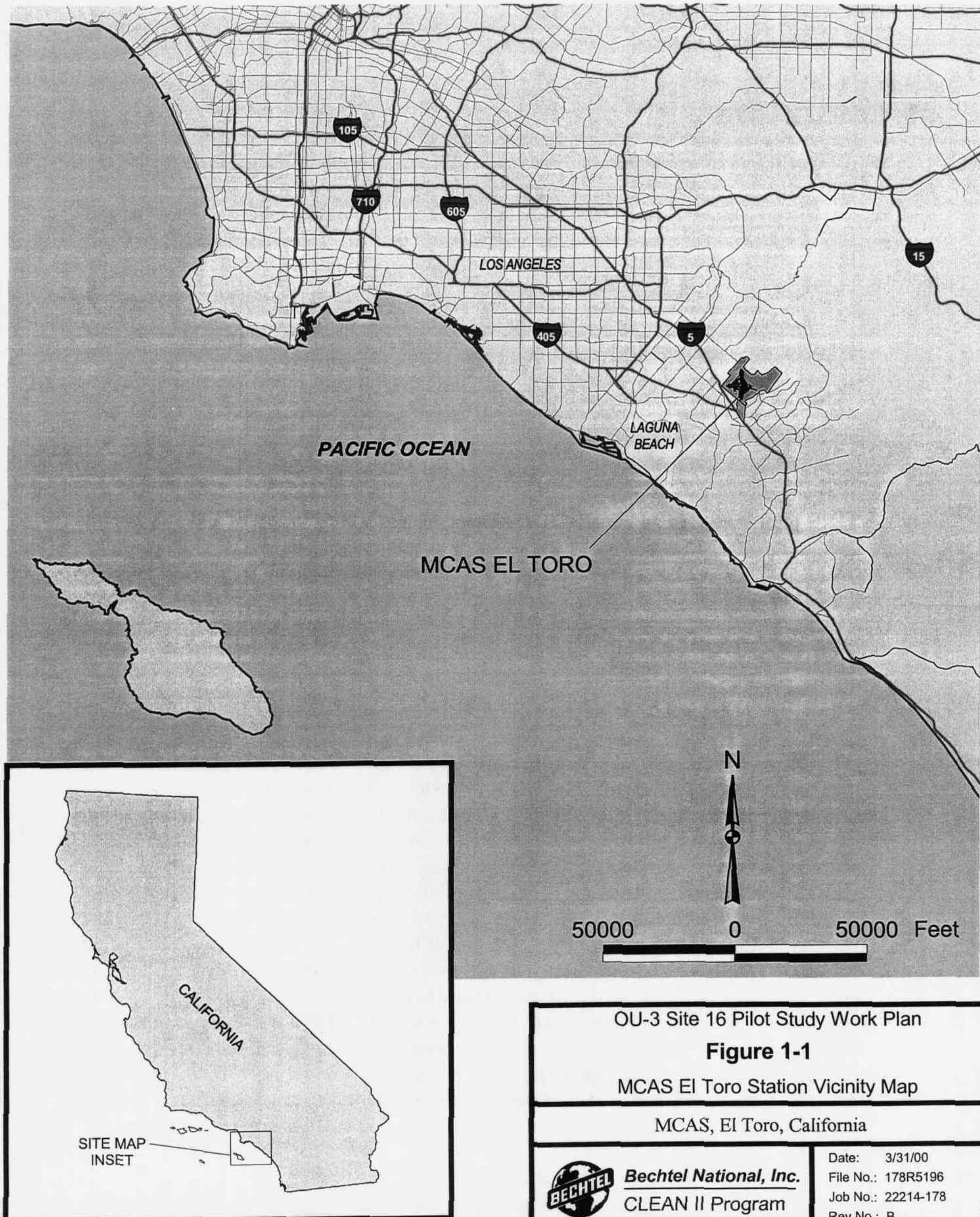
This Work Plan describes a multiphase extraction (MPE) pilot study at Installation Restoration Program (IRP) Site 16, Operable Unit 3, Marine Corps Air Station (MCAS) El Toro. The MPE pilot study is part of a phase II feasibility study (FS). The test will provide information to be used in evaluating the alternatives presented in the draft Phase II draft FS Report for Site 16.

Bechtel National, Inc. (BNI), has prepared this Work Plan on behalf of the U.S. Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV), in accordance with Contract Task Order (CTO)-0178 issued under the Comprehensive Long-Term Environmental Action Navy (CLEAN) II Program, contract No. N-68711-92-D-4670. This Work Plan has been prepared in accordance with the United States Environmental Protection Agency (U.S. EPA) Guidance for Conducting Treatability Studies Under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. EPA 1992a).

This Work Plan describes MPE and its use as a remedial technology, the objectives of the pilot study, and data collected on soil and groundwater conditions, as well as contaminant distribution relevant to the pilot study. In addition, this document discusses well locations and construction details, test equipment, test methods, and data evaluation and presents the schedule for field activities. MPE was selected in the draft FS Report as an applicable technology based on site conditions. In addition, MPE is also a presumptive remedy indicated by U.S. EPA.

1.1 SITE DESCRIPTION AND HISTORY

Site 16, Crash Crew Pit No. 2, is located in the center of the airfield, near the intersection of Runways 34-16 and 25-07 (Figure 1-1). The site contained three unlined fire-training pits (main pit, residual fluids pit, and the handheld extinguisher pit), of which the main pit is still present (Figure 1-2). Site 16 encompasses approximately 1 acre and consists of three units: Unit 1, an approximately 320- by 260-foot area consisting of a buffer zone surrounding the three pits used for firefighter training exercises; Unit 2, the area of the three unlined earthen pits (main pit, residual fluids pit, and hand-held fire training pit) situated within the boundary of the Unit 1; and Unit 3, a low drainage swale located northwest of the pits, terminating at a storm drain inlet near the intersection of El Toro Boulevard and closed Runway 21. Site 16 was used by the MCAS El Toro crash crew between 1972 and 1985 as a training area for firefighters. During training exercises, the main pit was filled with water and covered with various mixtures of residual fuels and other combustible fluids (e.g., jet propellant–Grade 5 [JP-5] fuel, aviation gasoline, crankcase oil, and other wastes). The mixtures were then ignited and extinguished by the firefighters. Water was used as the primary means of extinguishing the fires during the practice sessions. The residual fluids pit, connected to the main pit by a buried pipe, served as a regulating and storage reservoir for the additional water applied to the main pit during each exercise.



OU-3 Site 16 Pilot Study Work Plan

Figure 1-1

MCAS El Toro Station Vicinity Map

MCAS, El Toro, California

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CLEAN II Program

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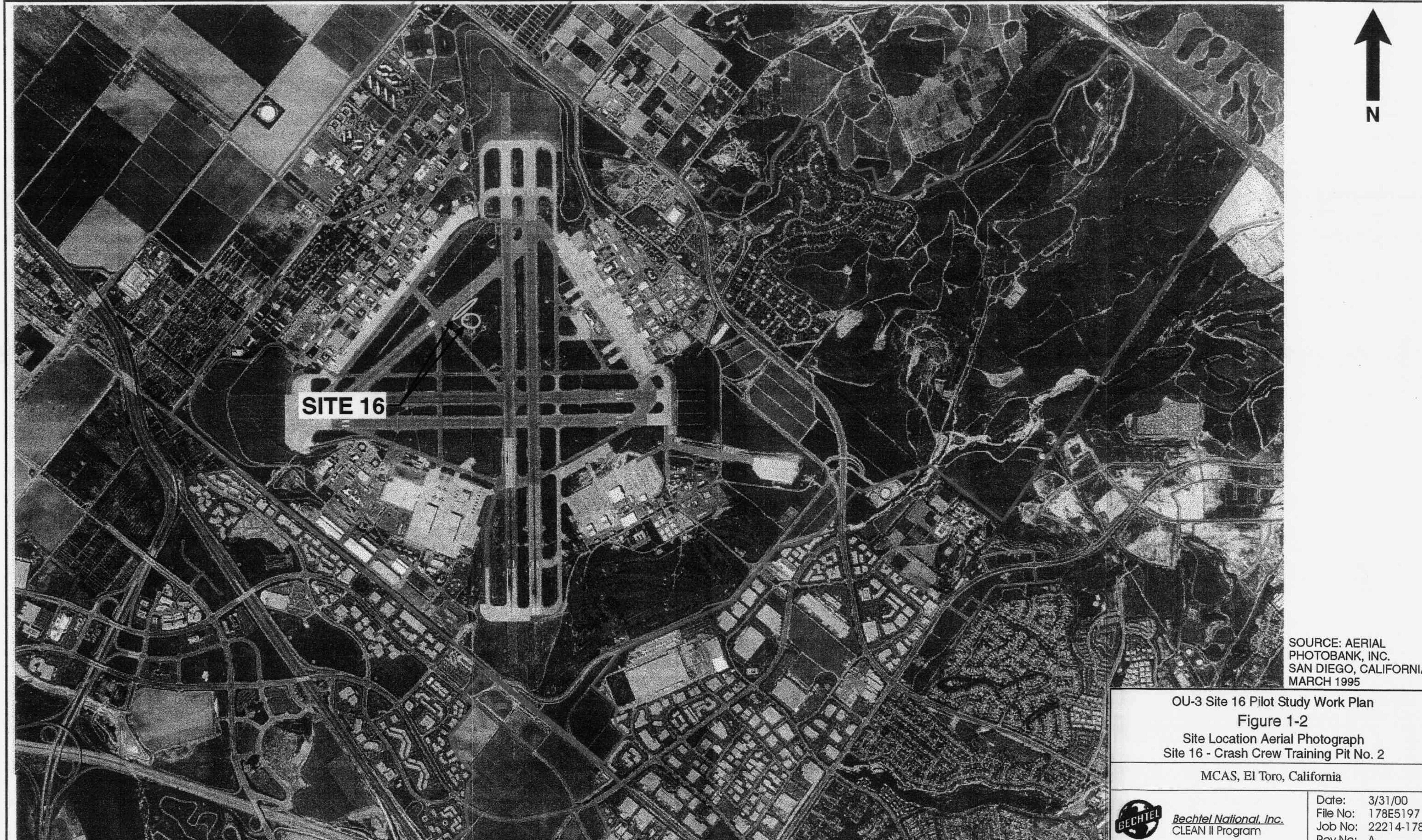
Job No.: 22214-178
Rev No.: B



SOURCE: AERIAL PHOTOBANK, INC.
SAN DIEGO, CALIFORNIA
MARCH 1995

OU-3 Site 16 Pilot Study Work Plan

Figure 1-2

Site Location Aerial Photograph

Site 16 - Crash Crew Training Pit No. 2

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 3/31/00
File No: 178E5197
Job No: 22214-178
Rev No: A

PAGE NO. 1-4

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As a result of these fire-fighting training activities, soil and groundwater beneath Site 16 are contaminated with VOCs and petroleum hydrocarbons, as discussed in the Phase II RI Report (BNI 1997). As a result of the RI, the Base Realignment and Closure Cleanup Team agreed that further action at Units 1 and 2 was warranted, based on the concentrations of volatile organic compounds (VOCs) in the soil and groundwater and that no further action was appropriate for Unit 3. (Therefore, this Work Plan does not address Unit 3.)

The RI Report recommended an FS to evaluate and recommend alternatives to remedy the contaminants beneath Units 1 and 2. The draft FS Report presented two potential remedial alternatives (2a through e [MPE with vapor activated carbon treatment of extracted vapor] and 3a through e [MPE with thermal oxidation of extracted vapors]) for Units 1 and 2, in addition to the no action alternative. Alternatives 2a–e and 3a–e utilize MPE with various treatment and/or disposal options for extracted vapor and groundwater (BNI 2000). Because no action at Site 16 would result in the migration of contamination, the two alternatives were developed for the draft FS Report.

Pilot tests are generally performed during the FS process to provide sufficient data to allow treatment alternatives to be fully developed and evaluated or evaluate the effectiveness of a potential remedial technology at a contaminated site. In the case of Site 16, the pilot study is being conducted to evaluate the effectiveness of the MPE technology in removing site contaminants.

The objective of the MPE pilot study at Site 16 is to collect data to evaluate MPE at Site 16. The data will be used to design a full-scale MPE system. The pilot study data may also be used to reduce cost and performance uncertainties for treatment alternatives so that a remedy can be selected. The results of the pilot study will be evaluated and presented in the draft final Phase II FS Report for Site 16.

1.2 REMEDIAL TECHNOLOGY DESCRIPTION

MPE is a U.S. EPA presumptive remedy for VOCs in soil and groundwater (U.S. EPA 1997). MPE is an enhancement of soil vapor extraction (SVE) technology, which is one of the preferred U.S. EPA presumptive remedies for VOC-contaminated soil (U.S. EPA 1993a). MPE was developed primarily for remediation of VOCs in low- to moderate-permeability soils. It enhances VOC recovery by extracting soil vapor and groundwater simultaneously from the same well.

The objective of MPE is to remove VOCs from the vadose zone before they further contaminate groundwater, while simultaneously remediating groundwater. During the process, the saturated zone is dewatered, allowing SVE to extract VOCs sorbed to the previously saturated soil. In addition, the vacuum applied to a well that is also pumping groundwater increases the water yield of the well, thereby increasing recovery of VOCs dissolved in groundwater.

1.3 MPE PILOT STUDY RATIONALE

The suitability and characteristics of an MPE system depends on site-specific criteria. The purposes of the pilot study at Site 16 are as follows.

- Collect data to evaluate MPE for collection and treatment of VOCs in soil and groundwater at Site 16 (BNI 2000).
- Reduce cost and performance uncertainties for MPE technology at Site 16.

Remedial action objectives (RAOs) were formulated for Site 16 based on site conditions and possible exposure pathways to provide a basis for remedial alternatives applicable to Site 16. The following RAOs were presented in the draft FS Report (BNI 2000).

- The RAOs to be addressed for the vadose zone beneath Site 16 consist of the following.
  - Reduce concentrations of VOCs in the area beneath the main pit (source area) to prevent or minimize further degradation of the shallow groundwater unit.
  - Limit or contain, to the extent feasible, the release of VOCs to groundwater until VOC soil and/or soil gas concentrations are below threshold concentrations (concentrations capable of contaminating groundwater above MCLs).
- The RAOs to be addressed for the shallow groundwater unit beneath Site 16 consist of the following.
  - Prevent domestic use of the shallow groundwater unit beneath Site 16 containing VOCs above MCLs.
  - Prevent further migration of VOC-contaminated groundwater from the source area.
  - Remove, to the extent feasible, VOCs above MCLs dissolved in the shallow groundwater unit beneath Site 16.

If pilot testing indicates that MPE can be successfully implemented at Site 16 a full-scale system will be designed to meet the RAOs.

The United States Environmental Protection Agency (U.S. EPA) developed the data quality objectives (DQO) process as a tool for project managers to determine the type, quantity, and quality of data needed to make decisions. Data produced by sampling and monitoring activities are used extensively in problem definition, rule-making, and enforcement decisions. These activities are supported through implementation of the mandatory U.S. EPA Quality System, which requires all organizations to develop and operate management processes and structures for assuring that the data collected are of the needed and expected quality for their desired use (U.S. EPA 1993b). The DQO process consists of seven steps.

1. *State the problem.* Describe the problem at the site as it is currently understood. The problem statement includes a site conceptual model and an organization and review of all relevant data.
2. *Identify the decision.* Determine an "if-then" statement that will define what the investigation will seek to determine and what actions will be taken based on the possible outcomes of the investigation.
3. *Identify inputs to the decision.* Specify the analytes or parameters to be measured and used.
4. *Define the study boundary.* Delineate the study boundary from information obtained from Step 1.
5. *Develop a decision rule.* Restate the decision detailing the if-then statement in specific terms.
6. *Specify acceptable limits on decision errors.* Specify how the data will be treated statistically and what the acceptable limits of uncertainty are.
7. *Optimize the design.* Design the field investigation, giving adequate consideration to the results of Steps 5 and 6. This step is detailed further in the Field Sampling Plan (FSP).

The following sections present the DQOs for the MPE pilot study at Site 16.

1.3.1 Step 1 – State the Problem

As a result of fire-fighting training activities, soil beneath Site 16 is contaminated with VOCs, PAHs, and petroleum hydrocarbons. The VOCs have also impacted groundwater at the site; VOC concentrations in groundwater now exceed maximum contaminant levels (MCLs). The VOC reported at the highest concentration and with the greatest frequency was trichloroethene (TCE). The highest TCE concentration in groundwater at Site 16, 540 micrograms per liter (μg/L), was reported immediately below the main pit. For more information on the distribution of contaminants in soil and groundwater at Site 16, see Section 2.

The draft FS Report presented two remedial alternatives (2a through e and 3a through e). Both alternatives utilized MPE with various treatment and/or disposal options for extracted vapor and groundwater. The primary objective of this pilot study is to evaluate the effectiveness of the MPE technology and collect additional site-specific information to support remedial action at Site 16. The results of the pilot study will be evaluated and presented in the draft final Phase II FS Report for Site 16.

1.3.2 Step 2 – Identify the Decision

For Site 16, the following decision will be considered.

> Does MPE as presented in the draft FS Report have the ability to prevent further migration of VOC-contaminated groundwater and/or remove, to the extent feasible, VOCs above MCLs dissolved in the shallow groundwater unit beneath Site 16?

1.3.3 Step 3 – Identify the Inputs to the Decision

Inputs that affect the decisions listed in Step 2 are:

- identification of the alternatives presented in the draft FS Report to be evaluated,
- identification of chemicals of concern (COCs) and associated actions levels for protection of human health,
- locations of the soil and groundwater monitoring/extraction wells to be installed and/or utilized during the pilot study and associated geologic and hydrogeologic conditions,
- results of the chemical analyses of soil vapor and groundwater samples collected during the MPE pilot study, and
- evaluation of all data collected during the MPE pilot study.

1.3.3.1 IDENTIFICATION OF THE ALTERNATIVES PRESENTED IN THE FS REPORT

The alternatives for Site 16 were developed based on the goal of reducing the soil TCE concentrations below the concentration threshold (32 μg/L) that could potentially load groundwater to the TCE MCL of 5 μg/L. These alternatives (except for no action) all utilize MPE for vapor and groundwater extraction at Site 16. This pilot study will evaluate MPE technology use at Site 16.

1.3.3.2 IDENTIFICATION OF COCs AND ASSOCIATED ACTION LEVELS TO PROTECT HUMAN HEALTH

The COCs at Site 16 are those reported in the Phase II RI Report (BNI 1997). Because not all of these chemicals contribute significantly to human-health risk at the site, the cleanup criteria and alternative development was based on the chemicals that account for the greatest human-health risk via groundwater exposure, which are VOCs, specifically TCE. Although several VOCs were reported in groundwater at Site 16, TCE is the most prevalent contaminant, and it was reported at higher concentrations (by one order of magnitude or greater) than the other VOCs in groundwater (Table 1-1). Therefore, alternatives, and this pilot study, were developed based on concentrations of TCE in soil and groundwater. Table 1-1 lists the COCs and action levels (i.e., federal and state MCLs).

The fate and transport analysis presented in the RI Report suggests that the TPH mass present in the vadose zone beneath Site 16 is not a threat to groundwater because it is generally immobile due to the low rainfall and net infiltration (BNI 1997). However, the MPE pilot study will evaluate the effects of MPE on the biodegradation of site-specific contaminants and whether petroleum hydrocarbons in the vadose zone are being biologically degraded.

Table 1-1
Chemicals Reported in Site 16 Monitoring Well and HydroPunch Groundwater Samples
(results reported in micrograms per liter)

Chemical of Concern	Chemical Abstract Service Number	Maximum Concentration	Federal MCL	California MCL
Volatile Organic Compounds				
Benzene	71-43-2	1 J	5	1
Chloroform	67-66-3	130	80	100
1,2-dichloroethane	107-06-2	8.7	5	0.5
1,1-dichloroethene	75-35-4	23	7	6
Ethylbenzene	100-41-4	2.7	700	700
Freon 113	76-13-1	18	—*	—
Methylene chloride	75-09-2	5.5	5	5
Toluene	108-88-3	0.45 J	1,000	150
Trichloroethene	79-01-6	540	5	5
Xylenes	1330-20-7	12 J	10,000	1,750
Semivolatile Organic Compounds				
bis(2-ethylhexyl) phthalate	117-81-7	1 J	—	—

Note:
*— - no criteria or limits have been established

Acronyms/Abbreviations:
J - estimated value
MCL - maximum contaminant level

1.3.3.3 LOCATIONS OF WELLS FOR THE PILOT STUDY AND ASSOCIATED GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

The locations of the extraction and monitoring wells to be installed and/or utilized during the pilot study were based on the requirements of the alternative development as well as geologic and hydrogeologic information for Site 16. For detailed information on the proposed well locations and site geology/hydrogeology, see Sections 2 and 3.

1.3.3.4 RESULTS OF THE CHEMICAL ANALYSES OF SOIL VAPOR AND GROUNDWATER SAMPLES COLLECTED DURING THE PILOT STUDY

The results of soil vapor and groundwater samples analyzed by a fixed-based laboratory will be verified and validated. Then the data will be used to assess the effectiveness of MPE at Site 16.

1.3.3.5 EVALUATION OF ALL DATA COLLECTED DURING THE PILOT STUDY

Data collected during the MPE pilot study will be used to evaluate the effectiveness of MPE. In addition, the data collected may also be used to support the remedial design of a selected alternative for Site 16.

1.3.4 Step 4 – Define the Study Boundary

The physical boundaries of this study include Site 16 and the area of the TCE plume. The temporal boundaries of the MPE pilot study will be the approximate 8-week period over which the well installation and testing will be conducted (Section 6).

1.3.5 Step 5 – Develop a Decision Rule

Decision rules are required to explicitly state the types of inputs and the logical basis for choosing an action during the MPE pilot study. The following decision rules form the approach for the pilot study. For the locations of pilot-testing wells, see Figure 3-1.

Aquifer testing:

1) The aquifer step-drawdown pumping tests will be conducted at wells 16MPE1 and 16GE1 for approximately 12 hours to help select the pumping rate for the constant rate testing at these wells. If the 12-hour test is not sufficient to calculate a rate for the constant-rate pumping tests, then the step-drawdown tests may be extended for a longer period of time as determined by the site hydrogeologist to collect the required data.
2) The constant-rate tests will be conducted for an initial duration of approximately 2 days. The aquifer test data will be reviewed as it is collected from extraction and observation wells to allow the hydrogeologist to monitor the test progress. If necessary, then the hydrogeologist may make adjustments to the aquifer test based on these field interpretations, where appropriate, to collect the required data to evaluate the test and groundwater extraction at Site 16.
3) The aquifer constant rate pumping test will be conducted at a rate that is not likely to exceed well yield for the duration of the test, based on the results of the step-drawdown test. If for any reason this rate cannot be maintained at the prescribed constant rate, or if sufficient data have been accumulated, then the recovery phase of the aquifer test will begin. If necessary, the constant-rate test may be restarted at a lower pumping rate after equilibrium conditions are established.
4) To begin the recovery phase of the aquifer test, the pump will be shut off and the data logger restarted and water levels will continue to be monitored. As with the constant-rate test, water levels will be measured by hand to assure correct operations of the pressure transducers. If the water level recovers to 90 percent of its static level (or as directed by hydrogeologist), then the recovery phase may be terminated.

SVE/MPE Testing:

5) If sufficient data to estimate the aquifer parameters has been obtained from the aquifer testing, then an approximately 24-hour SVE pilot test will be conducted at 16MPE1 to obtain baseline VOC concentrations and vapor flow rates prior to implementing MPE.
6) If the SVE pilot testing is successful (i.e., if data collected during the SVE pilot testing is sufficient to be used to estimate the radius of influence (ROI) and VOC concentrations at 16MPE1), then the MPE pilot test will be conducted (groundwater extraction in conjunction with SVE) beneath the TCE hot spot to evaluate MPE at Site 16. If SVE pilot testing is unsuccessful, the pilot study will be complete.
7) If after 2 weeks of pilot testing, sufficient analytical and physical data have been collected to evaluate MPE, then the pilot test will end.

For details on the procedures and protocols for the pilot study, see Section 4 and the Field Sampling Plan (FSP) (Attachment A).

1.3.6 Step 6 – Specify Tolerance Limits on Decision Errors

The purpose of Step 6 is to specify the tolerance limits for decision errors, which are used by the decision makers to establish performance goals for the data collection design. However, the sampling design for the MPE pilot study is judgmentally based, therefore, no statistical limits on uncertainty have been specified.

The purpose of a judgmental sampling design is to provide answers to more specific questions or issues where considerable information on parameters of a population already exists. Confidence and power limits associated with statistically based sampling designs do not apply directly to judgmentally located samples. Decision errors must still be considered for judgmental samples; however, they are not evaluated statistically.

The decision errors associated with judgmental sampling are based on sample design errors and measurement errors. Assuming the best possible professional judgment was used in conjunction with existing site data to develop the judgmental sampling regime for the pilot study, the most important decision errors will be associated with field and laboratory techniques involved with collection and analysis of the data. Thus, careful application of field and laboratory techniques is critical because corroborative data from multiple sample locations may not be available nor will they be statistically evaluated. For details on sampling methods and procedures, see Attachment A. The Quality Assurance Project Plan (QAPP) (Attachment B) addresses quality requirements for analytical laboratory testing data.

1.3.7 Step 7 – Optimize the Design

The sampling design was developed to optimize resources and generate data to satisfy the pilot study DQOs . Historical site activities, previous site investigation results, the RI/FS documents, and regulatory agency comments were used to formulate the sampling approach for the MPE pilot study.

During the pilot study, influent and effluent soil vapor and groundwater samples will be collected and analyzed. Soil vapor and groundwater samples will be analyzed prior to treatment and subsequent to treatment to evaluate mass removal rates as well as MPE technology efficiency. For details on sampling methods and procedures, see Section 5 of Attachment A (FSP).

1.4 WORK PLAN STRUCTURE

This Work Plan is divided into seven sections and five attachments, as follows.

- Section 1 provides the purposes of the pilot study, describes the scope of work, and provides the methodology that will be used to perform the work.
- Section 2 presents the soil and groundwater conditions at Site 16 including geology/lithology, hydrogeologic conditions as well as distribution of contaminants.
- Section 3 presents the rationale for the locations of the proposed pilot study wells and summarizes the construction details of these wells.
- Section 4 describes the installation, start-up, and implementation of the MPE pilot study.
- Section 5 describes how the collected data will be analyzed to accomplish the project goals.
- Section 6 provides the project schedule.
- Section 7 provides the references cited in this Work Plan.
- Attachment A contains the FSP for the MPE fieldwork activities.
- Attachment B contains the QAPP for the MPE fieldwork activities.
- Attachment C contains the IDW Management Plan (IDWMP) for the MPE fieldwork activities.
- Attachment D contains the Site-Specific Safety and Health Plan Supplement (SSHP) for the MPE fieldwork activities.
- Attachment E contains the Data Management Plan (DMP) for the MPE fieldwork activities.

Section 2
SITE CONDITIONS

This section presents the soil and groundwater conditions at Site 16, including geology, lithology, and hydrogeology , as well as distribution of contaminants.

2.1 SOIL AND GROUNDWATER CONDITIONS

The geology of Site 16 consists of Quaternary alluvial and marine deposits. Holocene deposits consist of fine-grained overbank deposits and coarse-grained stream channel deposits. These soils are derived from the Santa Ana Mountains to the east and conformably overlie Pleistocene interbedded fine-grained lagoonal and nearshore marine deposits. Pleistocene deposits unconformably overlie semiconsolidated marine sandstones, siltstones, and conglomerates of the late Miocene to late Pliocene, which are considered to be bedrock in the area (JEG 1993).

Lithologic data from the soil borings and cone penetrometer test (CPT) logs from Site 16 indicate that the alluvial sediments at this site consist of interbedded, lenticular strata composed of clay, silt, clayey to silty sand, and fine- to coarse-grained sand with traces of gravel. The gravel lenses within the sand and silt units are probably associated with stream channel deposits. The predominant lithologic types are silts, clays, and silty sand, with some sand.

A notable feature of Site 16 is the frequency and thickness of sand strata directly beneath the location of the main burn pit. Although finer-grained strata predominate at Site 16, the sand and silty sand strata appear thicker beneath the main pit. Laterally from the pit, the silty sand and sand strata appear generally reduced in thickness, and the finer-grained strata are more prevalent. The presence of a greater proportion of sand throughout the unsaturated zone beneath the main burn pit may provide a preferential pathway for the migration of liquids in the burn pit downward to the water table (BNI 2000).

MCAS El Toro lies within the Irvine Forebay I Groundwater Subbasin, which has been designated by RWQCB Santa Ana Region as a public water supply source (RWQCB 1995). Regional aquifers in this basin tend to be composed of discontinuous lenses of clayey and silty sands and fine-grained gravels contained within a complex assemblage of sandy clays and sandy silts. Two general aquifer systems have been identified near the station: a shallow aquifer zone and a lower principal aquifer in bedrock.

The shallow aquifer is present beneath Site 16 at a depth of about 165 feet below ground surface (bgs). The groundwater flow direction is to the northwest. The local hydraulic gradient has been influenced strongly by the pumping of irrigation wells located west of MCAS El Toro. Based on the most recent groundwater monitoring data, the groundwater gradient across the site is toward the northwest (Figure 2-1).

2.2 CONTAMINANT DISTRIBUTION

The following sections summarize the contaminant distribution information presented in the RI Report and the draft FS Report for Site 16 (BNI 1997, 1999).

2.2.1 Nature and Extent of Vadose Zone Contamination

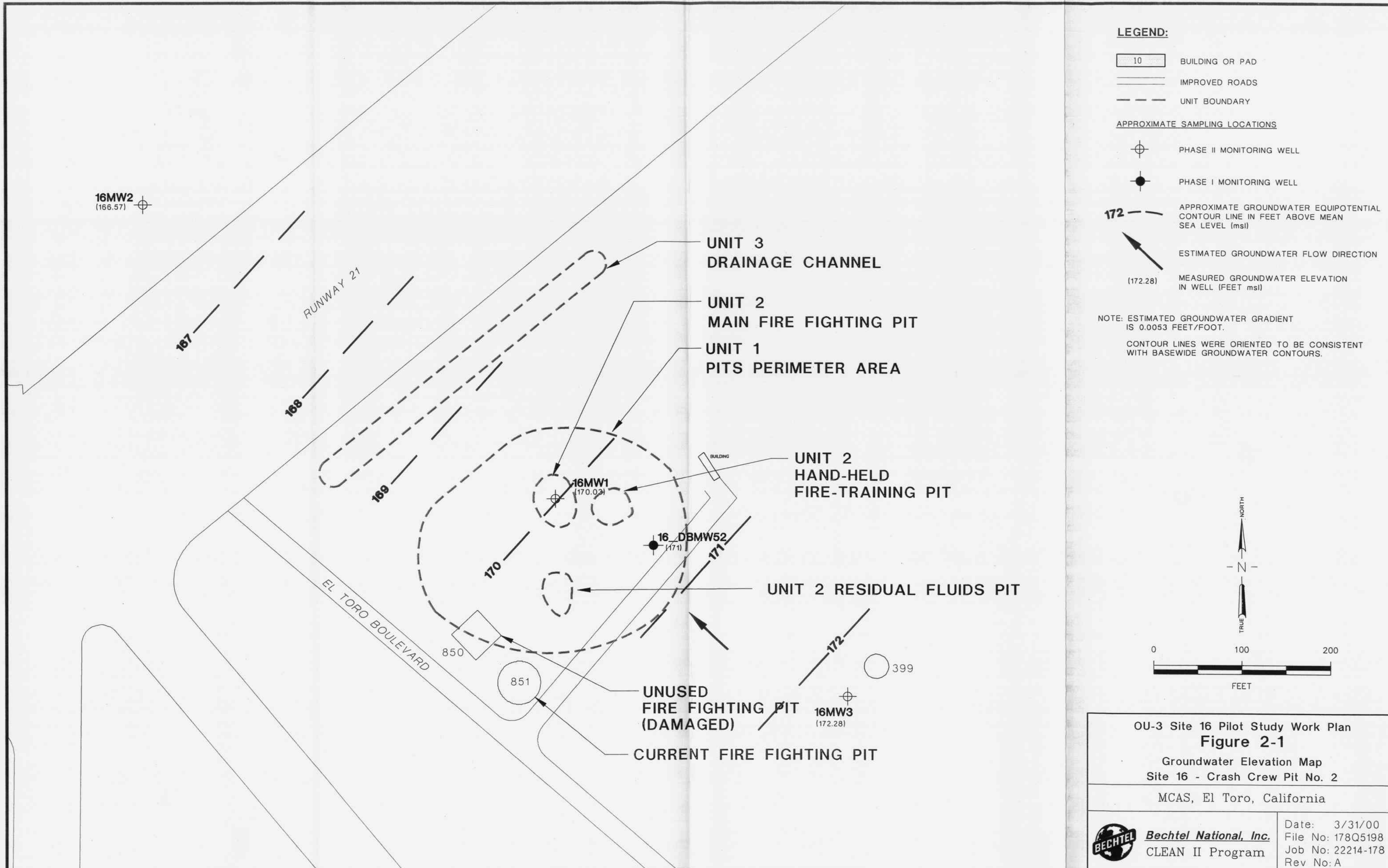
Evaluation of the field-screening and fixed-base laboratory analytical results for soil samples collected within Unit 3 during the RI conducted in 1992 and 1996 indicate that VOCs, polynuclear aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and target analyte list (TAL) metals are present in shallow soil throughout Unit 3. With the exception of TAL metals, none of the chemicals were reported in shallow soil at depths greater than 2 feet bgs. While metals at concentrations above background were present in shallow-soil (less than 10 feet bgs) samples to depths of approximately 5 feet bgs throughout Unit 3, their presence in the 5- to 10-foot-bgs half of the shallow-soil interval was noted in only a single sample from one boring. Based on these results, deeper subsurface soil (greater than 10 feet bgs) beneath Unit 3 was not sampled. Unit 3 was recommended for no further action (NFA) in the RI Report (BNI 1997).

The field-screening and fixed-base laboratory analytical results for soil samples collected in shallow soil at Units 1 and 2 during the RI in January 1996 indicated the presence of VOCs, semivolatile organic compounds (SVOCs), PAHs, and petroleum hydrocarbons above detection limits and TAL metals above background levels. These classes of chemicals were reported predominantly in the main pit, although they were also reported in the residual fluids pit at lower concentrations. The class of chemicals reported most frequently and at the greatest concentrations were petroleum hydrocarbons. The VOCs most often reported above detection limits were ethylbenzene, toluene, TCE, and xylenes (BNI 1997).

The highest concentrations of VOCs, SVOCs, PAHs, and petroleum hydrocarbons in deeper subsurface soil are beneath the main burn pit. Figures 2-2 through 2-5 present sampling locations, cross sections, and TCE concentrations. VOCs are present throughout the deeper subsurface-soil interval from 10 feet bgs into the water table (approximately 160 feet bgs). SVOCs, PAHs, and petroleum hydrocarbons were identified in soil samples to a depth of approximately 132 feet bgs beneath the main pit (BNI 1997).

VOCs, SVOCs, PAHs, and petroleum hydrocarbons were also reported above detection limits in soil beneath the location of the residual fluids pit. However, these contaminants were reported at concentrations significantly lower than those in the soil beneath the main pit. In addition, none of these contaminants were reported below 30 feet bgs other than toluene and TCE, which were reported only at low concentrations (less than or equal to 3 μg/L) at 142 and 172 feet bgs. It appears very likely that the reported TCE is related to the groundwater contamination associated with the main pit. Further, the only TCE concentrations reported in soil beneath the residual fluids pit were those at 142 and 172 feet bgs (BNI 1997).

In May through June 1999, soil gas samples were collected from varying depths at six locations at Site 16. The depths from which the soil gas samples were collected were determined based on location-specific lithology obtained from CPT lithologic logging prior to soil gas sample collection (BNI 2000).



LEGEND:
10
BUILDING OR PAD
IMPROVED ROADS
UNIT BOUNDARY
APPROXIMATE SAMPLING LOCATIONS
PHASE II MONITORING WELL
PHASE I MONITORING WELL
172
APPROXIMATE GROUNDWATER EQUIPOTENTIAL CONTOUR LINE IN FEET ABOVE MEAN SEA LEVEL (msl)
ESTIMATED GROUNDWATER FLOW DIRECTION
(172.28)
MEASURED GROUNDWATER ELEVATION IN WELL (FEET msl)
NOTE: ESTIMATED GROUNDWATER GRADIENT IS 0.0053 FEET/FOOT.
CONTOUR LINES WERE ORIENTED TO BE CONSISTENT WITH BASEWIDE GROUNDWATER CONTOURS.
16MW2
(166.57)
RUNWAY 21
167
168
169
170
171
172
UNIT 3
DRAINAGE CHANNEL
UNIT 2
MAIN FIRE FIGHTING PIT
UNIT 1
PITS PERIMETER AREA
BUILDING
UNIT 2
HAND-HELD
FIRE-TRAINING PIT
16MW1
(170.03)
16_DBMW52
(171)
UNIT 2 RESIDUAL FLUIDS PIT
EL TORO BOULEVARD
850
851
399
UNUSED
FIRE FIGHTING PIT
(DAMAGED)
16MW3
(172.28)
CURRENT FIRE FIGHTING PIT
NORTH
N
TRUE
0
100
200
FEET
OU-3 Site 16 Pilot Study Work Plan
Figure 2-1
Groundwater Elevation Map
Site 16 - Crash Crew Pit No. 2
MCAS, El Toro, California
Bechtel National, Inc.
CLEAN II Program
Date: 3/31/00
File No: 178Q5198
Job No: 22214-178
Rev No: A

PAGE NO. 2-4

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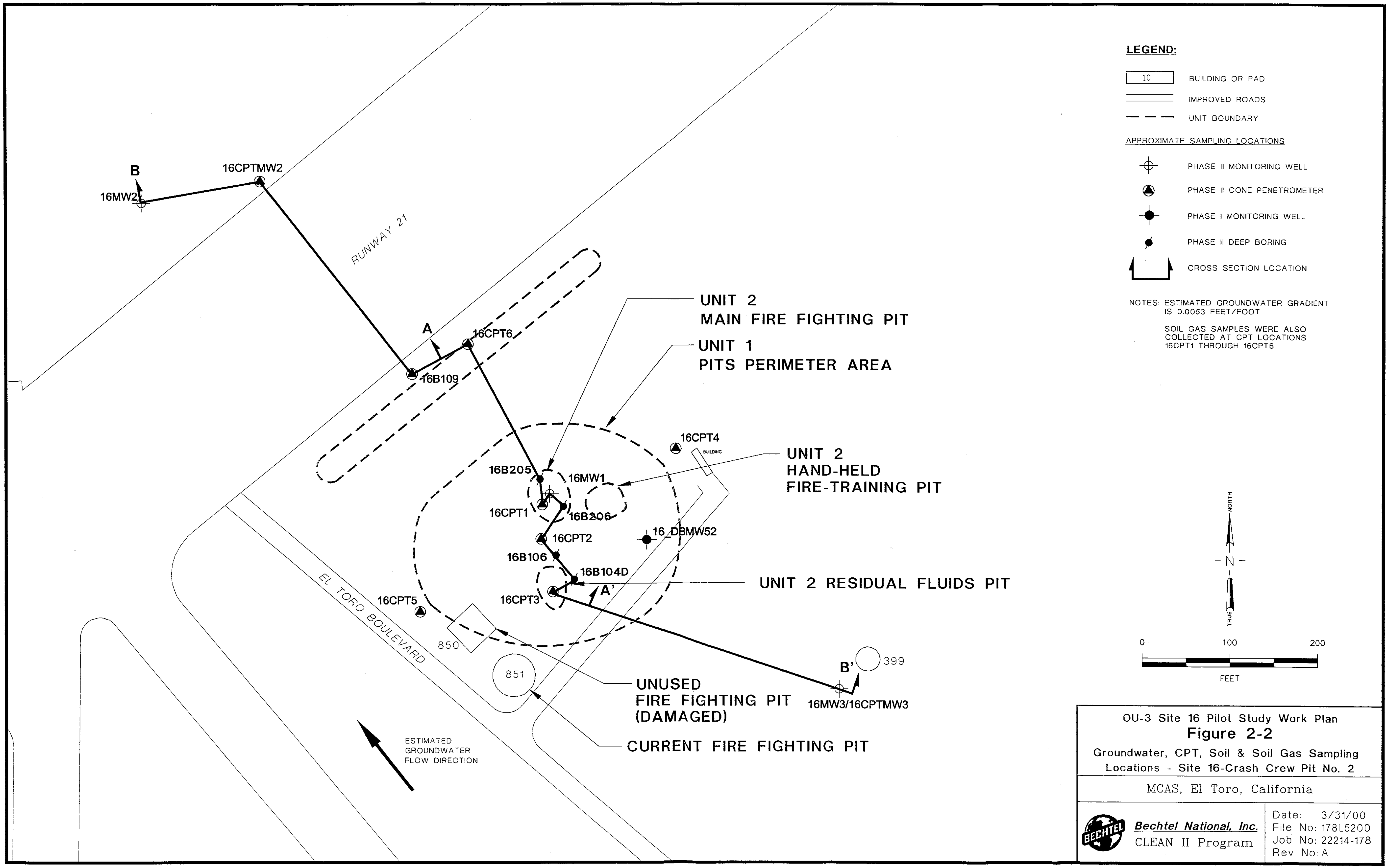
LEGEND:
10 BUILDING OR PAD
IMPROVED ROADS
UNIT BOUNDARY
APPROXIMATE SAMPLING LOCATIONS
PHASE II MONITORING WELL
PHASE II CONE PENETROMETER
PHASE I MONITORING WELL
PHASE II DEEP BORING
CROSS SECTION LOCATION
NOTES: ESTIMATED GROUNDWATER GRADIENT IS 0.0053 FEET/FOOT
SOIL GAS SAMPLES WERE ALSO COLLECTED AT CPT LOCATIONS 16CPT1 THROUGH 16CPT6
B
16CPTMW2
16MW2
RUNWAY 21
A
16CPT6
16B109
UNIT 2
MAIN FIRE FIGHTING PIT
UNIT 1
PITS PERIMETER AREA
16CPT4
UNIT 2
HAND-HELD
FIRE-TRAINING PIT
16B205
16MW1
16CPT1
16B206
16CPT2
16_DBMW52
16B106
16B104D
UNIT 2 RESIDUAL FLUIDS PIT
A'
16CPT5
16CPT3
EL TORO BOULEVARD
850
851
399
B'
16MW3/16CPTMW3
UNUSED
FIRE FIGHTING PIT
(DAMAGED)
CURRENT FIRE FIGHTING PIT
ESTIMATED
GROUNDWATER
FLOW DIRECTION
NORTH
N
TRUE
0
100
200
FEET
OU-3 Site 16 Pilot Study Work Plan
Figure 2-2
Groundwater, CPT, Soil & Soil Gas Sampling Locations - Site 16-Crash Crew Pit No. 2
MCAS, El Toro, California
BECHTEL
Bechtel National, Inc.
CLEAN II Program
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Job No: 22214-178
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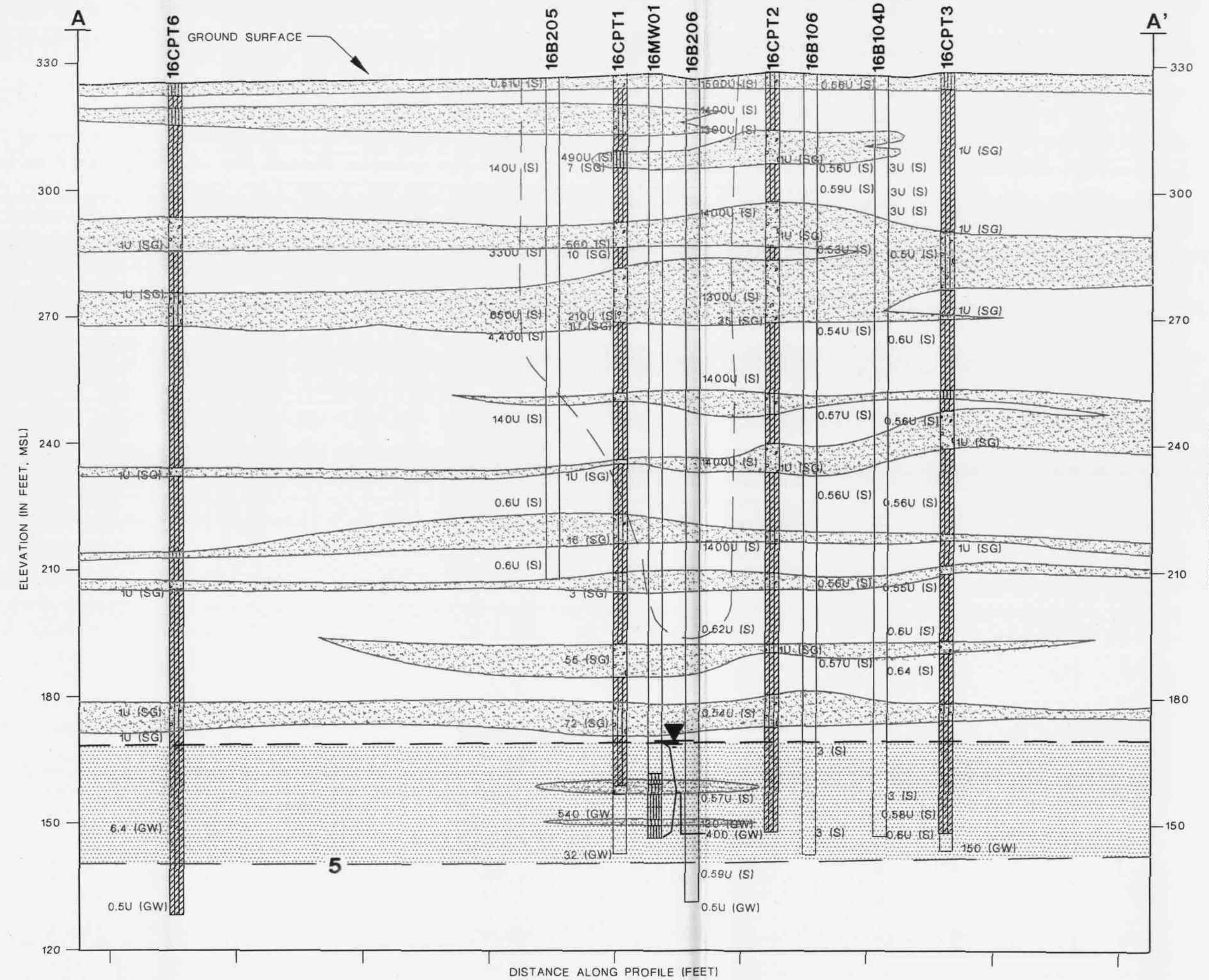

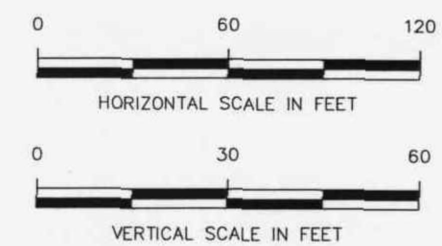

LEGEND

LITHOLOGIC LOGS:

SP
SW
SC
ML
SM
CL
GW
GP
INTERVAL NOT LOGGED OR SHOWN
SANDY SILT
CLAYEY SILT
SAND AND SILTY SAND, INTERBEDDED
CLAY AND SILT, INTERBEDDED

GENERAL LITHOLOGIC UNITS:

PREDOMINATNTLY COARSE GRAINED
PREDOMINATLY FINE GRAINED

ESTIMATED EXTENT OF TCE GROUNDWATER CONTAMINATION ABOVE 5 ug/L
INTERPRETED LITHOLOGIC BOUNDARY
INTERPRETED WATER TABLE

APPROXIMATE WATER LEVEL IN MONITORING WELL
ESTIMATED EXTENT OF PETROLEUM HYDROCARBONS IN SOIL ABOVE 500 mg(kg) (NOTE: RESULTS NOT SHOWN FOR CLARITY)

TCE SAMPLE RESULTS:

(S)	SOIL SAMPLE (ug/kg)
(SG)	SOIL GAS SAMPLE (ug/L)
(GW)	GROUNDWATER SAMPLE (ug/L)
U	SAMPLE RESULT LESS THAN DETECTION LIMIT

OU-3 Site 16 Pilot Study Work Plan

Figure 2-3

Geologic Cross Section A-A' in Vicinity of Main Firefighting Pit

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

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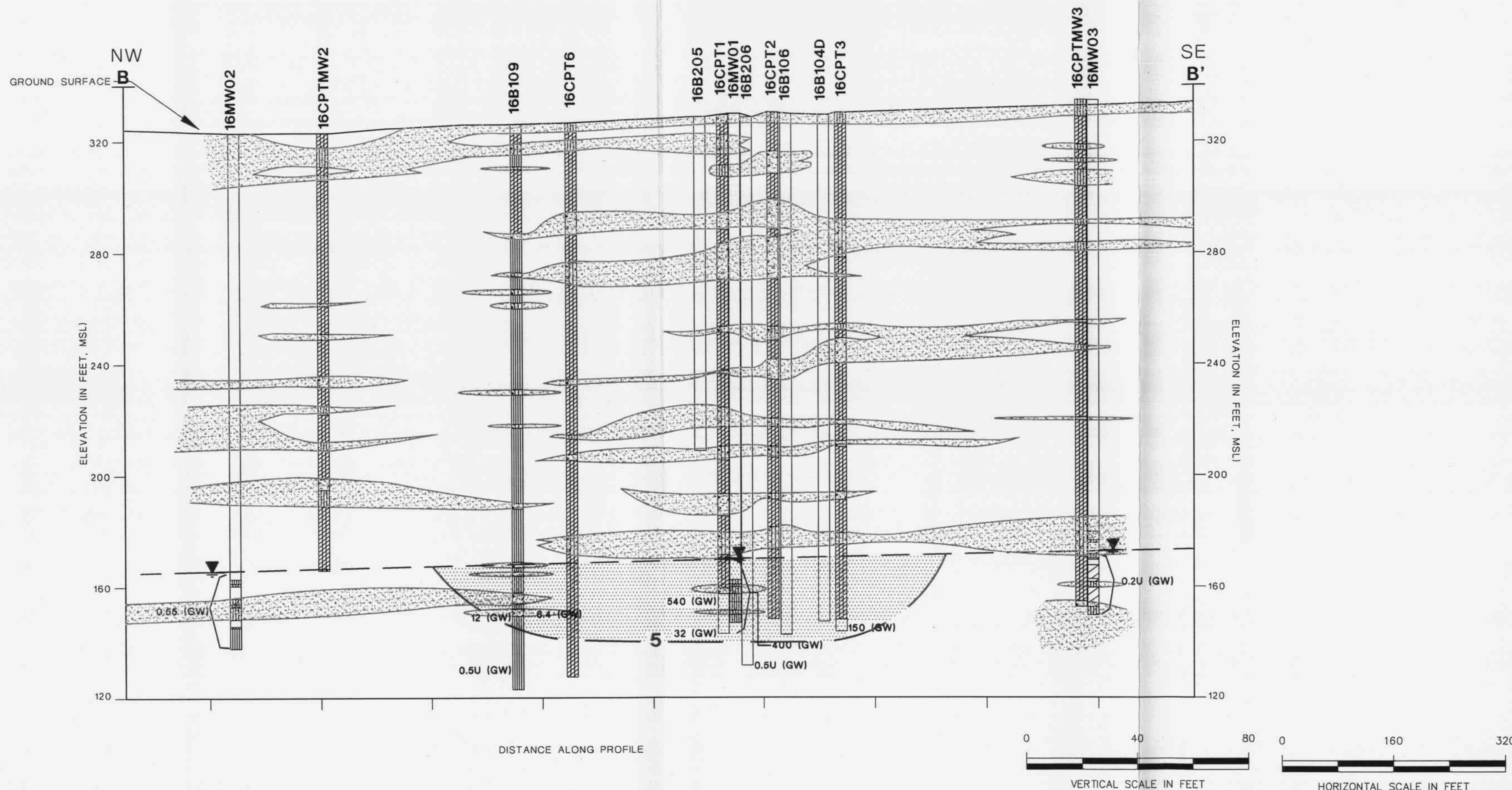

LEGEND

LITHOLOGIC LOGS:

SP
GW
SW
GP
SC
INTERVAL NOT LOGGED OR NOT SHOWN
ML
SANDY SILT
SM
CLAYEY SILT
CL
SAND AND SILTY SAND, INTERBEDDED

CLAY AND SILT, INTERBEDDED

GENERAL LITHOLOGIC UNITS:

PREDOMINANTLY COARSE GRAINED

PREDOMINATELY FINE GRAINED

NOTE: LITHOLOGY SHOWN ONLY FOR CPT LOGS OR IF BOREHOLES WERE CONTINOUSLY CORED; OTHER LOGS HAD INSUFFICIENT DETAIL.

ESTIMATED EXTENT OF TCE GROUNDWATER CONTAMINATION ABOVE MCL OF 5ug/L

INTERPRETED LITHOLOGIC BOUNDARY

INTERPRETED WATER TABLE

APPROXIMATE WATER LEVEL IN MONITORING WELL

TCE SAMPLE RESULTS

(GW) GROUNDWATER SAMPLE (ug/L)

U SAMPLE RESULT LESS THAN DETECTION LIMIT

OU-3 Site 16 Pilot Study Work Plan

Figure 2-4

Geologic Cross Section B-B' with Groundwater Results

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

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File No: 178X5202
Job No: 22214-178
Rev No: B

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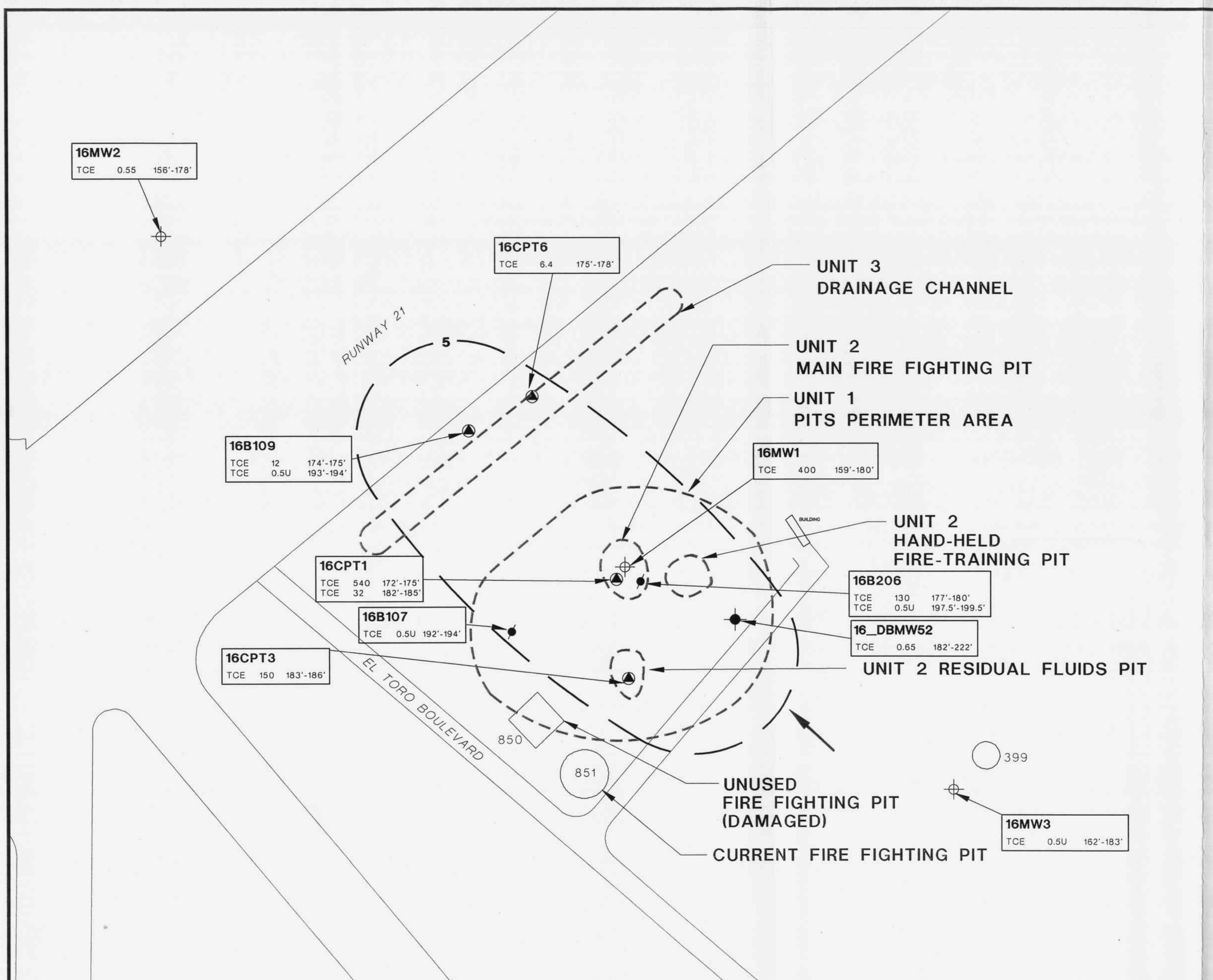

LEGEND:

10 BUILDING OR PAD

IMPROVED ROADS

UNIT BOUNDARY

APPROXIMATE SAMPLING LOCATIONS

PHASE II MONITORING WELL

PHASE II CONE PENETROMETER

PHASE I MONITORING WELL

PHASE II DEEP BORING

5 APPROXIMATE EXTENT OF TCE IN GROUNDWATER ABOVE THE MCL OF 5 ug/L

ESTIMATED GROUNDWATER FLOW DIRECTION

SAMPLE LOCATION

16CPT1
TCE 540 175'
TCE 32 185'

DEPTH (IN FEET) SAMPLE TAKEN

ANALYTE

REPORTED CONCENTRATION (IN ug/L)

NOTES: ESTIMATED GROUNDWATER GRADIENT IS 0.0053 FEET/FOOT

DEPTH TO GROUNDWATER IS APPROXIMATELY 160 FEET BELOW GROUND SURFACE (bgs)

U - SAMPLE RESULT LESS THAN DETECTION LIMIT

NORTH
- N -
TRUE

0 100 200
FEET

OU-3 Site 16 Pilot Study Work Plan

Figure 2-5

TCE Concentrations in Groundwater
Site 16 - Crash Crew Pit No. 2

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

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File No: 178A5203
Job No: 22214-178
Rev No: A

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The results of the on-site analyses of soil gas samples indicated that concentrations of total VOCs in soil gas at the depths/locations sampled ranged from 828 to less than 1 µg/L (Table 2-1). The highest concentrations of total VOCs (828 µg/L) were reported at SG-01 (16CPT1) at 154 feet bgs (Table 2-1). 16CPT1 was advanced through the center of the main pit. The VOCs reported in soil gas samples included trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), 1,1-dichloroethane (DCA), cis-1,2-dichloroethene (DCE), TCE, benzene, toluene, ethylbenzene, m- and p-xylenes, and o-xylene (BNI 2000).

The results of the soil gas sampling indicate that the highest concentrations of TCE in soil gas at Site 16 are beneath the main pit (the primary source area). In addition, below approximately 100 feet these concentrations increase with depth beneath the main pit with the highest concentrations reported at 154 feet bgs. In contrast, the highest concentrations of petroleum hydrocarbons and VOCs in soil are present above approximately 100 feet bgs.

2.2.2 Nature and Extent of Saturated Zone Contamination

Groundwater is encountered at Site 16 at approximately 160 feet bgs beneath the main pit. The analytical results of the most recent groundwater sampling (16MW1, 16MW2, and 16MW3), performed at Site 16 in July 1999, indicate that VOCs present in groundwater at concentrations exceeding 1 µg/L include chloroform, 1,2-DCA, methylene chloride, and TCE (BNI 2000). Also reported at concentrations less than 1 µg/L was toluene. HydroPunch® sampling performed in May 1999 indicates that benzene, ethylbenzene, and xylenes are also present in groundwater at Site 16 at concentrations less than 15 µg/L (Table 2-2).

The VOC for which the highest concentrations in groundwater have been reported at Site 16 is TCE. TCE was reported at a concentration of 540 µg/L in a HydroPunch sample from 16CPT1 at 175 feet bgs and at a concentration of 400 µg/L in well 16MW1. Both of these sample locations are directly beneath the main burn pit (Figure 2-4). The TCE concentrations diminish within a relatively short distance downgradient, as is evidenced by the 0.55-µg/L concentration in 16MW2, located approximately 500 feet downgradient of the main burn pit. Groundwater data collected from HydroPunch sampling indicate that VOCs were not reported below a vertical depth of approximately 30 feet below the water table at the locations sampled (BNI 2000).

Several VOCs have been reported in groundwater at Site 16. However, because TCE is the most prevalent contaminant and is reported at higher concentrations (by one order of magnitude or greater) than other VOCs, delineation of the VOC groundwater plume beneath Site 16 has been based on concentrations of TCE (BNI 2000).

Overall, groundwater sampling data suggest that the area containing concentrations of TCE in groundwater above its MCL of 5 µg/L (the TCE plume) extends from approximately 200 feet southeast of the main pit (upgradient) to approximately 330 feet northwest of the main pit (downgradient) (Figure 2-5). The average lateral width of the plume is approximately 200 feet and the vertical thickness of the plume is estimated to be 30 feet. Based on the most recent groundwater monitoring data, the groundwater gradient across the site is approximately 0.006 feet per foot toward the northwest (BNI 2000).

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Table 2-1
Summary of Field Analytical Results for Soil Gas Samples at Site 16
(units reported in micrograms per liter)

Sample Identification	Boring Depth (feet)	Date of Sampling	Total VOCs	F-11	F-113	1,1-DCA	cis-1,2-DCE	TCE	Benzene	Toluene	Ethylbenzene	Xylenes
1786101-01	SG-01 @ 20	05/24/1999	231	1 U	102	1 U	2	7	16	61	12	31
1786105-02	SG-01 @ 41	05/24/1999	415	4	338	2	4	10	15	29	5	8
1786107-02	SG-01 @ 58	05/24/1999	12	1 U	12	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786108-01	SG-01*	05/24/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786109-01	SG-01 @ 95	05/24/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786110-02	SG-01 @ 110	05/24/1999	350	5 U	334	5 U	5 U	16	5 U	5 U	5 U	5 U
1786111-01	SG-01*	05/25/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786112-01	SG-01 @ 123	05/25/1999	50	1 U	47	1 U	1 U	3	1 U	1 U	1 U	1 U
1786113-04A	SG-01 @ 139	05/25/1999	608	8	543	1 U	2	55	1 U	1 U	1 U	1 U
1786114-04B	SG-01 @ 154	05/25/1999	828	12	744	5 U	5 U	72	5 U	5 U	5 U	5 U
1786115-01	SG-02 @ 22	05/25/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786116-01	SG-02 @ 39	05/25/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786117-01	SG-02*	05/26/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786118-01	SG-02 @ 58	05/26/1999	59	1 U	24	1 U	1 U	35	1 U	1 U	1 U	1 U
1786119-01	SG-02 @ 95	05/26/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786120-01	SG-02 @ 138	05/26/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786121-01	SG-03 @ 20	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786122-01	SG-03*	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786123-01	SG-03 @ 38	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786124-01	SG-03 @ 58	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786125-01	SG-03 @ 88	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786126-01	SG-03 @ 119	05/27/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786127-01	SG-04*	06/01/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786128-01	SG-04 @ 49	06/01/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786129-02	SG-04 @ 58	06/01/1999	8	1 U	8	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786130-01	SG-04 @ 115	06/01/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786131-01	SG-04 @ 141	06/01/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786132-01	SG-04 @ 155	06/01/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786133-01	SG-05 @ 49	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786134-01	SG-B5*	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786135-01	SG-05 @ 58	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786136-01	SG-05 @ 103	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786137-01	SG-05 @ 116	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786138-01	SG-05 @ 142	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786139-01	SG-05 @ 160	06/02/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786140-01	SG-06 @ 39	06/03/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786141-01	SG-B6*	06/03/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786142-02	SG-06 @ 51	06/03/1999	81	1 U	81	1 U	1 U	1 U	1 U	1 U	1 U	1 U

(table continues)

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Table 2-1 (continued)

Sample Identification	Boring Depth (feet)	Date of Sampling	Total VOCs	F-11	F-113	1,1-DCA	cis-1,2-DCE	TCE	Benzene	Toluene	Ethylbenzene	Total Xylenes
1786143-01	SG-06 @ 93	06/03/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786144-01	SG-06 @ 122	06/03/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786145-01	SG-06 @ 149	06/03/1999	8	1 U	8	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1786146-01	SG-06 @ 156	06/03/1999	0	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Note:
* soil gas equipment blank

Acronyms/Abbreviations:
DCA – dichloroethane
DCE – dichloroethene
F-11 – trichlorofluoromethane
F-113 – 1,1,2-trichlorotrifluoroethane
TCE – trichloroethene
U – nondetect
VOC – volatile organic compound

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Table 2-2
HydroPunch® and Groundwater Monitoring Well Analytical Sample Results (May and July 1999)
(results reported in micrograms per liter)

			TCE	Benzene	bis(2-ethylhexyl)phthalate	Chloroform	Ethylbenzene	Methylene Chloride	Toluene	Xylenes	1,2-DCA
U.S. EPA MCL			5	5	None	100	700	None	1,000	10,000	5
California MCL			5	1	None	70	700	None	150	1,750	0.5
Location	**Depth (feet)**	**Date Sampled**									
16CPT1[a]	175	05/14/1999	540	ND	ND	130	ND	ND	ND	ND	ND
16CPT1[a]	185	05/14/1999	32	1 J	ND	0.86	2.7	ND	ND	14	ND
16CPT3[a]	185	05/19/1999	150	ND	ND	ND	ND	ND	ND	7.9	ND
16CPT6[a]	175	05/17/1999	6.4	ND	ND	ND	ND	ND	0.45 J	ND	ND
16MW52	202[b]	05/18/1999	0.65 J	ND	ND	0.38 J	ND	ND	ND	ND	ND
16MW1	170[b]	07/14/1999	400	ND	1 J	24	ND	ND	ND	ND	ND
16MW2	168[b]	07/13/1999	0.55	ND	1 J	ND	ND	5.5	0.39	ND	8.7
16MW3	173[b]	07/12/1999	ND	ND	1 J	ND	ND	3.3	ND	ND	0.45

Notes:
[a] HydroPunch sample
[b] bladder pump inlet depth

Acronyms/Abbreviations:
DCA – dichloroethane
J – estimated value
MCL – maximum contaminant level
ND – not detected
TCE – trichloroethene
U.S. EPA – United States Environmental Protection Agency

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Section 3
MPE PILOT STUDY WELL INSTALLATION

This section presents the rationale for locations of MPE, groundwater extraction, groundwater monitoring, soil vapor monitoring (SVM), and dual-purpose monitoring wells and summarizes the construction details of these wells. It also discusses the groundwater sampling, geophysical survey, and land survey to be conducted in relation to well installation.

3.1 RATIONALE FOR WELL LOCATIONS

For the pilot study, one MPE well, one groundwater extraction well, two groundwater monitoring wells, two dual-purpose monitoring wells, and one vapor monitoring well will be installed (Figures 3-1 and 3-2). The MPE well will be located in the main pit because the highest concentrations of VOCs in soil and groundwater are within that area. In addition, beneath the main pit a greater percentage of coarse-grained sediments appear to be present and, therefore, these sediments may also provide a preferential pathway for vapor flow during the MPE pilot testing. The dual-purpose wells will be used to monitor soil gas and groundwater.

The seven wells to be constructed for the MPE pilot study at Site 16 will be installed utilizing an air rotary casing hammer (ARCH) drilling rig. Table 3-1 presents the total depths, screened intervals, and diameters proposed for these wells. The MPE well (16MPE1) will be located in the main pit approximately 25 feet from 16MW1. The groundwater extraction well (16GE1) will be located approximately 220 feet downgradient of 16MPE1. Groundwater monitoring wells 16MW4 and 16MW5 will be located approximately 20 feet southwest and 40 feet northeast respectively, from 16GE1. The vapor monitoring well 16SVM1 and dual-purpose wells 16MW6 and 16MW7 will be located approximately 50, 45, and 65 feet, respectively, from 16MPE1.

3.2 WELL DRILLING, SOIL SAMPLING, AND LITHOLOGIC LOGGING

As presented in Table 3-1, one MPE well, one groundwater extraction well, two new groundwater monitoring wells, and two dual purpose monitoring wells will be installed and developed for the MPE the pilot study. In addition, one vapor monitoring well will also be installed. The borings for the well installations will be drilled via an ARCH drilling rig with boring diameters of 8 to 10 inches (4-inch wells) and 12 inches (6-inch wells). Details of the sampling protocols to be followed during drilling of the wells are presented in the FSP (Attachment A).

The well boreholes will range in depth from approximately 155 feet below ground surface (bgs) for the vapor monitoring well to approximately 190 feet bgs for the other wells. The vapor monitoring well will be screened from approximately 145 feet to 155 feet bgs. The two dual-purpose monitoring wells will be screened from approximately 145 feet to 190 feet bgs. The groundwater monitoring wells will be screened from approximately 160 feet bgs (at the water table) to approximately 190 feet bgs. The MPE well will be screened from approximately 145 feet bgs (15 feet above the water table) to approximately 190 feet bgs and the groundwater extraction well will be screened from approximately 160 feet bgs (at the water table) to approximately

190 feet bgs. The exact depth of the screened intervals will be determined at the time of well construction based on the lithologic and hydrogeologic data from each location.

Based on previously collected soil data at Site 16, it has been estimated that all monitoring wells will be constructed with using 4-inch-diameter schedule 40 polyvinyl chloride solid casing and 0.020 slot stainless steel-wire wrap screen. The MPE and groundwater extraction wells will be constructed using 6-inch-diameter schedule 80 PVC solid casing and 0.020 slot stainless steel-wire wrap screen. However, if sieve analysis indicates a different slot screen is required, the slot size of the well screens will be reevaluated.

Soil samples will only be collected for geologic logging purposes within the aquifer material at the groundwater extraction and groundwater monitoring well locations. These soil samples will be collected continuously from the water table to the bottom of the borehole (approximately 30 feet). These soil samples, along with previously collected soil samples, as appropriate, will be used to evaluate (through sieve analysis) the appropriate screen slot size and filter pack for the wells. It is not necessary to collect soil samples in the vadose zone during drilling of groundwater extraction and monitoring wells, due the extensive soil sampling that has been previously been performed at Site 16. However, soil samples at selected depths may be collected at the discretion of the field geologist to confirm the stratigraphy at the screened portions of the vapor monitoring wells. Further, it is anticipated that soil samples collected will not be submitted for laboratory analyses.

3.3 GROUNDWATER SAMPLING

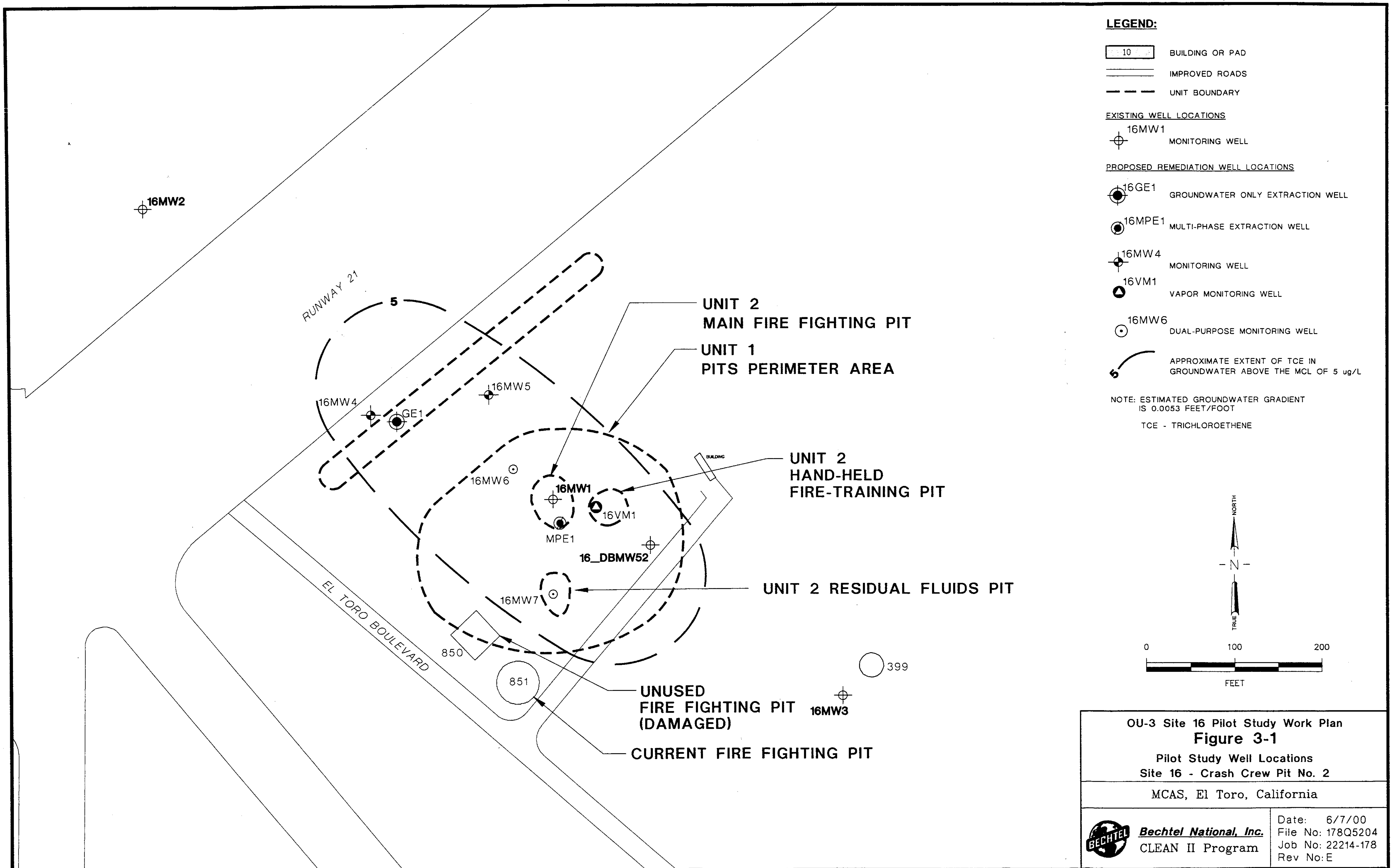
Following installation of the groundwater wells and prior to pilot testing, groundwater samples will be collected from the new and existing wells at Site 16. Groundwater sampling is discussed in Section 4 and in the FSP (Attachment A).

3.4 GEOPHYSICAL SURVEY

A geophysical survey will be conducted for all new MPE pilot study well locations at Site 16. A commercial utility locating firm will be subcontracted to clear the planned soil sampling locations using ground-penetrating radar, electromagnetic, and/or magnetometer methods. See the FSP (Attachment A) for more information on the geophysical survey.

3.5 SITE SURVEY

A land survey will be conducted for all new MPE pilot study well locations at Site 16. The locations and elevations of all new well locations will be surveyed by a professional licensed land surveyor following completion. See the FSP (Attachment A) for more information on the site survey.



OU-3 Site 16 Pilot Study Work Plan

Figure 3-1

Pilot Study Well Locations

Site 16 - Crash Crew Pit No. 2

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 6/7/00
File No: 178Q5204
Job No: 22214-178
Rev No: E

PAGE NO. 3-4

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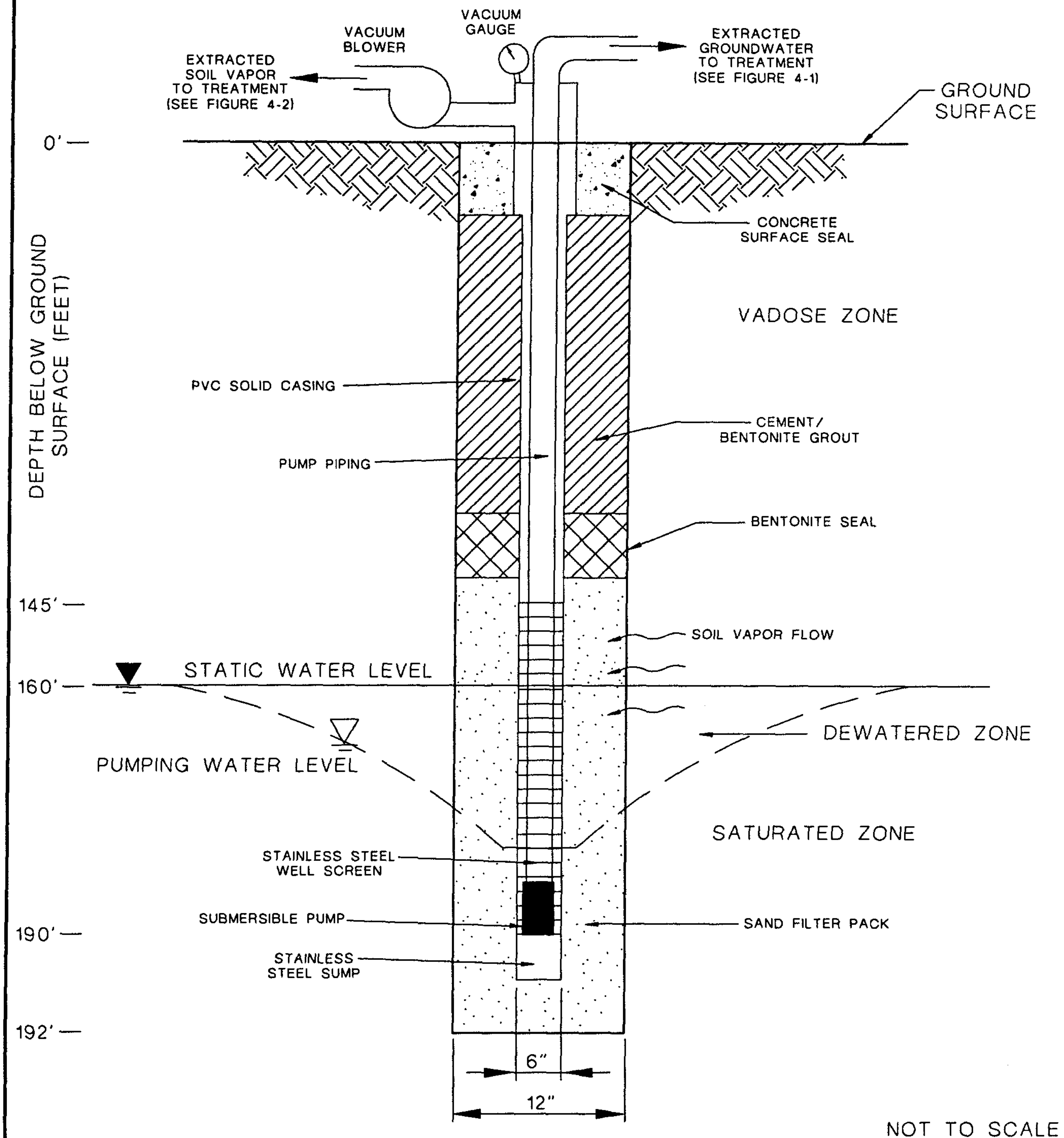


OU-3 Site 16 Pilot Study Work Plan

Figure 3-2

Proposed MPE Well

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 6/8/00
File No: 178X5205
Job No: 22214-178
Rev No: C

Table 3-1
Site 16 Multiphase Extraction Pilot Study Proposed Wells

Proposed Location	Total Depth (feet bgs)	Screened Interval[a] (feet bgs)	Diameter of Well Casing and Screen (inches)
16MPE1[b]	190	145 – 190	6[c]
16GE1[d]	190	160 – 190	6[c]
16MW4[e]	190	160 – 190	4[f]
16MW5	190	160 – 190	4[f]
16SVM1[g]	155	145 – 155	4[f]
16MW6[h]	190	145 – 190	4[f]
16MW7[h]	190	145 – 190	4[f]

Notes:
[a] the exact depth of the screened intervals will be determined at the time of well construction
[b] multiphase extraction
[c] well will be constructed using Schedule 80 polyvinyl chloride (PVC) solid casing and 0.020-slot stainless steel wire wrap screen
[d] groundwater extraction
[e] monitoring well
[f] well will be constructed using Schedule 40 PVC solid casing and 0.020-slot stainless steel wire wrap screen
[g] soil vapor monitoring well
[h] dual-purpose well; will be utilized for vapor and groundwater monitoring

Acronym/Abbreviation:
bgs – below ground surface

Section 4
MPE PILOT TEST INSTALLATION, START-UP, AND IMPLEMENTATION

This section describes equipment requirements, test preparation requirements, and procedures for the installation, start-up, and implementation of MPE pilot testing.

4.1 SUMMARY OF MPE PILOT TESTING

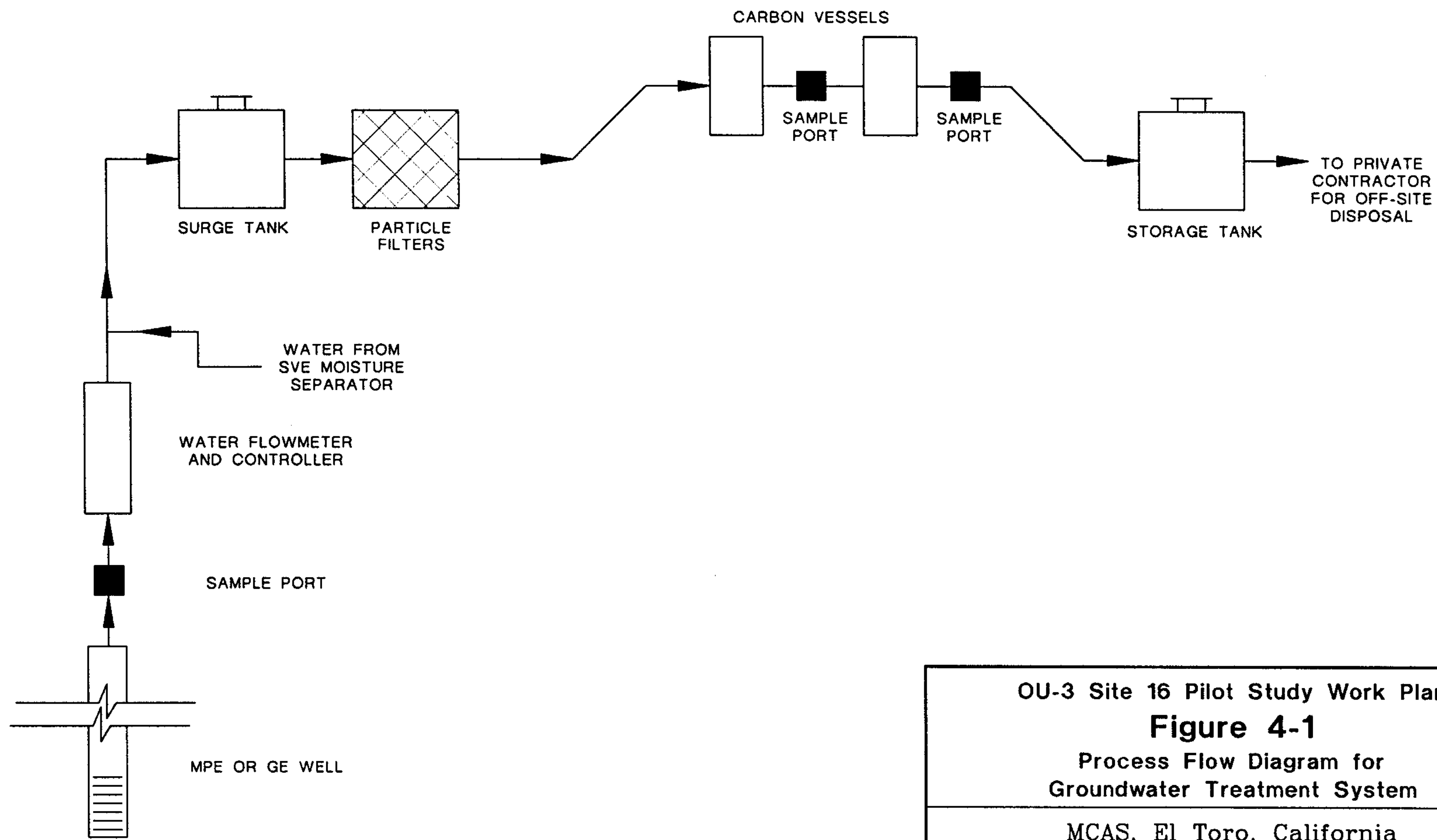
MPE is an enhancement of SVE technology developed primarily for remediation of soil vapor and groundwater simultaneously from the same well. Because this technology was proposed to be utilized at Site 16 in the draft FS Report, along with conventional groundwater extraction at downgradient locations, pilot tests for SVE, groundwater extraction, and MPE (SVE conducted in conjunction with groundwater extraction) need to be performed to evaluate the applicability and requirements of a full-scale system.

The MPE pilot test will be conducted at the MPE well (16MPE1). The aquifer tests to evaluate groundwater extraction will be preformed at the groundwater extraction well (16GE1) and 16MPE1. The type of aquifer tests to be performed will include step-drawdown and constant-rate drawdown tests.

Process flow diagrams illustrate how the components of the MPE pilot system will be assembled prior to initiating the pilot test (Figures 4-1 and 4-2). The MPE pilot system is a two-phased system that will extract both groundwater and soil vapor as separate process streams. Both of these components of the MPE pilot testing will be tested separately and in conjunction with each other. The following sections describe each phase of this two-phased system (SVE and groundwater extraction), briefly explain how they will be tested together to evaluate the MPE strategy at Site 16, describe the equipment required to perform the pilot testing, and present information on objectives, equipment startup, and implementation of the pilot study at Site 16.

4.2 MPE PILOT STUDY OBJECTIVES

The data collected will be analyzed to help evaluate MPE as presented in the alternatives in the draft FS Report. The alternatives presented in the draft FS Report were developed for Site 16 with the goal of reducing the soil gas TCE concentrations below the concentration threshold that could potentially load groundwater to the TCE MCL of 5 μg/L. They also included groundwater extraction from the source area and downgradient of the source area to control the TCE-contaminated groundwater plume at Site 16. The MPE pilot testing results will also be used to refine the cleanup time estimates for remediation of TCE contaminated soil and groundwater beneath Site 16. The MPE pilot study will also involve collecting soil gas samples for methane and fixed-gas analysis to assess the biological activity beneath Site 16. The results of these analyses will be evaluated to assess the effects of MPE on the biodegradation of site-specific contaminants and whether petroleum hydrocarbons in the vadose zone are being biologically degraded.



OU-3 Site 16 Pilot Study Work Plan

Figure 4-1

Process Flow Diagram for Groundwater Treatment System

MCAS, El Toro, California

Bechtel National, Inc.
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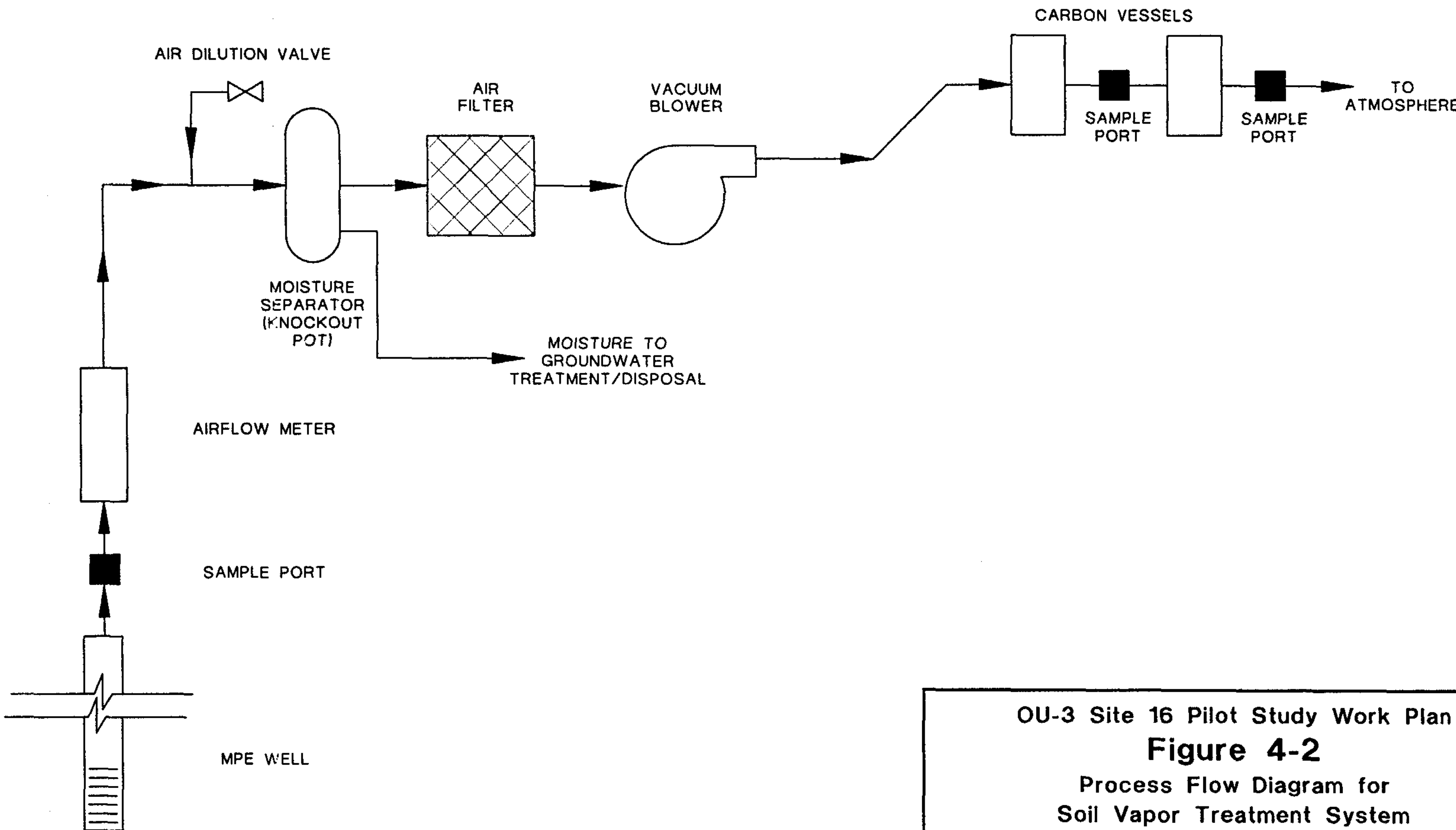
Job No: 22214-178
Rev No: C



MPE - MULTI-PHASE EXTRACTION

OU-3 Site 16 Pilot Study Work Plan

Figure 4-2

Process Flow Diagram for Soil Vapor Treatment System

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 5/18/00
File No: 178S5211
Job No: 22214-178
Rev No: C

The following lists the MPE pilot test objectives:

- evaluate the implementability of using SVE to remove VOCs from contaminated soil beneath the main pit at Site 16;
- evaluate SVE radius of influence for 16MPE1;
- estimate the mass of VOCs removed from the contaminated soil during the pilot test;
- evaluate VOC concentrations in soil gas during vacuum extraction and estimate the VOC removal rate and assess the overall effectiveness of SVE at 16MPE1;
- establish operating parameters (vacuum and airflow) needed to optimize SVE performance;
- evaluate whether one well (16MPE1) is sufficient to remediate contaminated soil at Site 16;
- evaluate the implementability of recovering contaminated groundwater beneath Site 16;
- evaluate groundwater extraction radius of influence;
- estimate the mass of VOCs removed from the contaminated groundwater during the pilot test;
- estimate the dissolved VOC removal rate and the overall effectiveness of groundwater extraction at the test wells;
- establish operating parameters (groundwater extraction rate and drawdown) needed to optimize groundwater extraction performance;
- evaluate whether MPE can accomplish removal of contaminant mass at sufficient rates to demonstrate that if carried out over a longer time period, MPE has the potential to achieve significant remediation and meet the remediation goals described in the draft FS Report; and
- collect sufficient data to estimate overall effectiveness, cost, and implementability of the full-scale operation of an MPE system at Site 16.

4.3 AQUIFER TESTING AND GROUNDWATER EXTRACTION SYSTEM

This section describes equipment requirements, test preparation requirements, and procedures for aquifer testing. This section was prepared using procedures and methods described in the U.S. EPA guidance document Suggested Operating Procedures for Aquifer Pumping Tests (U.S. EPA 1993c) and CLEAN Standard Operating Procedure (SOP) 14. The equipment and procedures will also be used for the groundwater extraction portion of the MPE test.

Two types of aquifer tests will be conducted at 16GE1 and 16MPE1: step-drawdown tests and constant-rate tests. Step-drawdown tests are used to estimate well yield (and longerterm pumping rates) by increasing the pumping rate in a stepwise fashion. Step-drawdown tests of approximately 12 hours in duration will be performed in 16GE1 and 16MPE1, followed by constant-rate tests in the two wells. The flow rates for the constant rate tests will be based on the step-drawdown test results. The constant-rate extraction tests will initially be approximately 2 days in length. The actual test duration may vary and will depend on field conditions. The extracted groundwater will be treated using a portable granular activated carbon (GAC) treatment system and stored in portable tanks on-site for subsequent discharge to Bee Canyon Wash via a storm drain located on-site.

4.3.1 Aquifer Test Equipment Requirements

General equipment and operation specifications required for aquifer testing are described below. This list does not include all equipment necessary to complete aquifer testing. Equipment will be specified during premobilization activities and is subject to change based on field conditions.

4.3.1.1 SUBMERSIBLE PUMP

The pump will be capable of pumping continuously at a rate that is sufficient for each aquifer test. The maximum potential pumping rate estimated from development of the three monitoring wells installed in July 1999 (16MW1, 16MW2, and 16MW3) is approximately 5 gallons per minute (gpm). For these tests, a 4-inch variable speed pump rated for a maximum of approximately 10 gpm at a head of 200 feet is initially specified. The pump must have a check valve to prevent backflow into the well during the recovery phase. The pump size for the constant-rate tests may be modified based on the step-test data.

4.3.1.2 POWER SUPPLY

Prior to mobilization of the submersible pumps for groundwater extraction during the aquifer and MPE testing, the power supply adjacent to Site 16 will be evaluated for its compatibility with this equipment. In addition, the power supply will be evaluated for compatibility with the groundwater treatment system transfer pump. If this power supply is not of sufficient quality and power to run the submersible and/or transfer pumps or requires extensive modification, a portable power supply consisting of a single 110/220-volt 50-kilowatt portable generator will be leased for the duration of the pilot testing for this purpose. It is assumed the generator vendor will provide refueling services. Depending on power requirements, the treatment system vendor may provide a generator.

4.3.1.3 FLOWMETERS AND CONTROLLERS

A flowmeter capable of providing accurate discharge measurements, with a sufficient measurement range for each aquifer test, will be used to measure groundwater extraction rates. The flowmeter must be capable of sufficient and timely flow measurements which enable field personnel to keep the flow rate from varying more than 5 percent. The flowmeter will be checked manually throughout the groundwater and MPE pilot testing.

Flow rates will be maintained using a manual valve of sufficient sensitivity to effectively keep the rate from varying more than 5 percent. If practical, an automatic (electrical powered) flow controller may be utilized to maintain the required flow rates over extended periods.

4.3.1.4 WATER-LEVEL MONITORING EQUIPMENT

A multiport data logger with pressure transducers and hand-operated water-level meters capable of measuring water-level changes of ± 0.01 feet will be used to measure water levels. Transducers installed in each well will be of the appropriate pressure rating to accurately measure the anticipated drawdown. This is particularly important for the extraction wells. The data logger has the capability of accurately and efficiently recording and transferring these water level readings electronically for later evaluation and computer program processing. The data logger, pressure transducers, and all components and connections will be thoroughly checked for proper operation prior to installing transducers in the wells.

4.3.1.5 WATER TREATMENT AND STORAGE SYSTEM

A portable (trailer- or skid-mounted) treatment system generally consisting of a surge tank, particulate filter, transfer pump, and two GAC canisters (in series) appropriately sized for the site conditions will be used to reduce VOC concentrations in discharged groundwater to levels below the laboratory reporting limit (0.5 μg/L). The surge tank will be used to provide short-term storage capacity and help remove suspended sediment before treatment and will be appropriately sized (estimated to be 500-gallon capacity). It is estimated that two 55-gallon capacity GAC canisters will be sufficient for the pilot testing, although the size will be specified during procurement of equipment. Secondary containment structures will be installed as necessary. Water sample ports will be installed at the required locations for influent and effluent sampling. The equipment will include appropriate automatic shutoff valves as needed to prevent tank overflows should the transfer pump fail. Treated groundwater will be stored in tanks (e.g., 6,500-gallon poly-tanks) until subsequent discharge to Bee Canyon Wash via a storm drain located on-site (Section 4.3.6).

4.3.2 Aquifer Pretest Preparation

The following preparation is needed before the start of each aquifer test. Prior to startup of pilot testing, all wells at Site 16 will be sampled to assess initial pretest VOC concentrations in groundwater. Groundwater sampling is described in Section 4.7.

4.3.2.1 ESTABLISH BACKGROUND WATER LEVELS

Water levels in all observation wells at Site 16 will be measured a minimum of once a day for 3 days before the installation of the pump and after the completion of the recovery phase of the aquifer test in a given well. All wells at Site 16 will also be measured immediately prior to each constant rate test to obtain initial test conditions. Data logger and transducers may be used to obtain background levels in selected wells. At least one well located outside the potential pumping influence will also be measured once a day before, during, and after all aquifer tests to serve as a background reference.

4.3.2.2 AQUIFER TEST HARDWARE SETUP

The pump will be installed in the extraction wells at least 24 hours prior to the start of the initial aquifer test at each well. The pumps will be installed near the bottom of the well to allow for maximum drawdown. Prior to installation of the pump for the 16MPE1 aquifer test, a special wellhead manifold will need to be installed to facilitate subsequent MPE testing. The pump discharge will be connected to the groundwater treatment system and storage tank (Figure 4-2). The power supply will be connected and the pump will be tested for proper operation. Pressure transducers will be installed in the extraction well and in the nearby observation wells. Transducers will be installed deep enough in the extraction and observation wells to assure submergence throughout the test. Pressure transducer response will be verified by raising and lowering the transducer in the well and checking the depth reading with a hand-operated water-level meter.

Before beginning the aquifer test, the pump, transducers, and data logger will be checked for correct operation. Sufficient time will be allowed for the well to recover before beginning the test (24 hours or water level recovered to predisturbed condition).

4.3.2.3 RECORD BAROMETRIC PRESSURE

Barometric pressure will be recorded before, during, and after each aquifer test. Pressure readings will be recorded concurrently with the water level readings using a barometric transducer connected to the data logger. This is important for evaluating the potential effects of barometric pressure changes on water levels during the test. As a check, the pressure reading may also be obtained periodically from a barometer located on-site. Ambient weather conditions will be noted throughout the test.

4.3.3 Aquifer Testing Procedures

This section describes the general test preparations and procedures for conducting the aquifer testing. Groundwater sampling will be conducted only from the extraction well during the standard aquifer tests in 16GE1 and 16MPE1. The frequency of sampling and the analyses to be conducted are described Section 4.7.

- Check the data logger to make certain that it and the pressure transducers are functioning.
- Start the pump and data logger simultaneously and quickly establish a stable discharge rate. Check the indicated discharge rate manually. The pumping rate will be measured and recorded throughout the test. The frequency will be approximately every 30 minutes while the rate is stable. An increased frequency (at startup) is required until the rate is stabilized. The flow rate should not vary by more than 5 percent.

- The cycle of water-level recording measurements should be started when beginning an extraction or recovery test, and at the start of each step during a step test. Table 4-1 presents the time intervals for recording water-level data. These intervals meet or exceed the maximum recommended time intervals for aquifer test water-level measurements in the pumping well according to the U.S. EPA aquifer test procedures (U.S. EPA 1993c). Water-level measurement frequency for the data logger indicated on Table 4-1 will be programmed into the data logger and collected automatically. Time intervals may be modified by the hydrogeologist depending on site conditions.
- Hand-held water-level meters will be used to check the correctness of the data logger readings and for measurement of water levels in more distant observation wells. Hand measurements will be completed at a frequency as shown in Table 4-1 or as directed by the project hydrogeologist. Actual recording intervals will depend on the aquifer test conditions.
- Aquifer test data will be plotted on semilog graphs as it is accumulated for extraction and observation wells to allow the hydrogeologist to monitor the test progress and make adjustments based on field interpretations, where appropriate. Data recorded by the data logger will periodically be downloaded on-site to a laptop computer during the tests to facilitate evaluating test progress.
- If for any reason the pumping rate cannot be maintained at the prescribed constant rate or if sufficient data have been accumulated, the recovery phase of the aquifer test will begin. If necessary, the constant-rate test will be restarted at a lower pumping rate after equilibrium conditions are established.
- To begin the recovery phase of the aquifer test, the pump will be shut off and the data logger restarted. Water levels will be measured by hand to verify correct operation of the pressure transducers. The recovery phase of the test may be terminated after the water level recovers to 90 percent of its static level in both the pumping and monitoring wells, or as directed by the project hydrogeologist. The pump shall not be removed from the extraction well during the recovery phase.
- The next test in the same well or a different nearby well shall not be started until the recovery phase is complete, or as directed by the project hydrogeologist.

4.3.4 Aquifer Step-Drawdown Testing

Step-drawdown tests will be performed at 16GE1 and 16MPE1 to help select the pumping rate for the constant-rate tests. The step tests will be performed after the water level in the well from pump installation or operation testing has returned to its static level. The step tests will begin at a rate selected by the project hydrogeologist. The rate of increase of subsequent steps will be based on the well's reaction to the previous pumping rate. Typically, four pumping steps are performed, although it can vary depending on site conditions.

Table 4-1
Maximum Recommended Time Intervals for Aquifer Test Water-Level Measurements

Time Into Extraction or Recovery Test	Data Logger Recording Interval	Hand Data Recording Interval
0 to 5 minutes	Every 5 seconds	Every 10 seconds
5 to 15 minutes	Every 30 seconds	Every minute
15 to 80 minutes	Every 1 minute	Every 2 minutes
80 to 240 minutes	Every 5 minutes	Every 10 minutes
4 to 24 hours	Every 30 minutes	Every 1 hour
24 to 48 hours	Every 1 hour	Every 2 hours
48 hours to shutdown	Every 4 hours	Every 8 hours

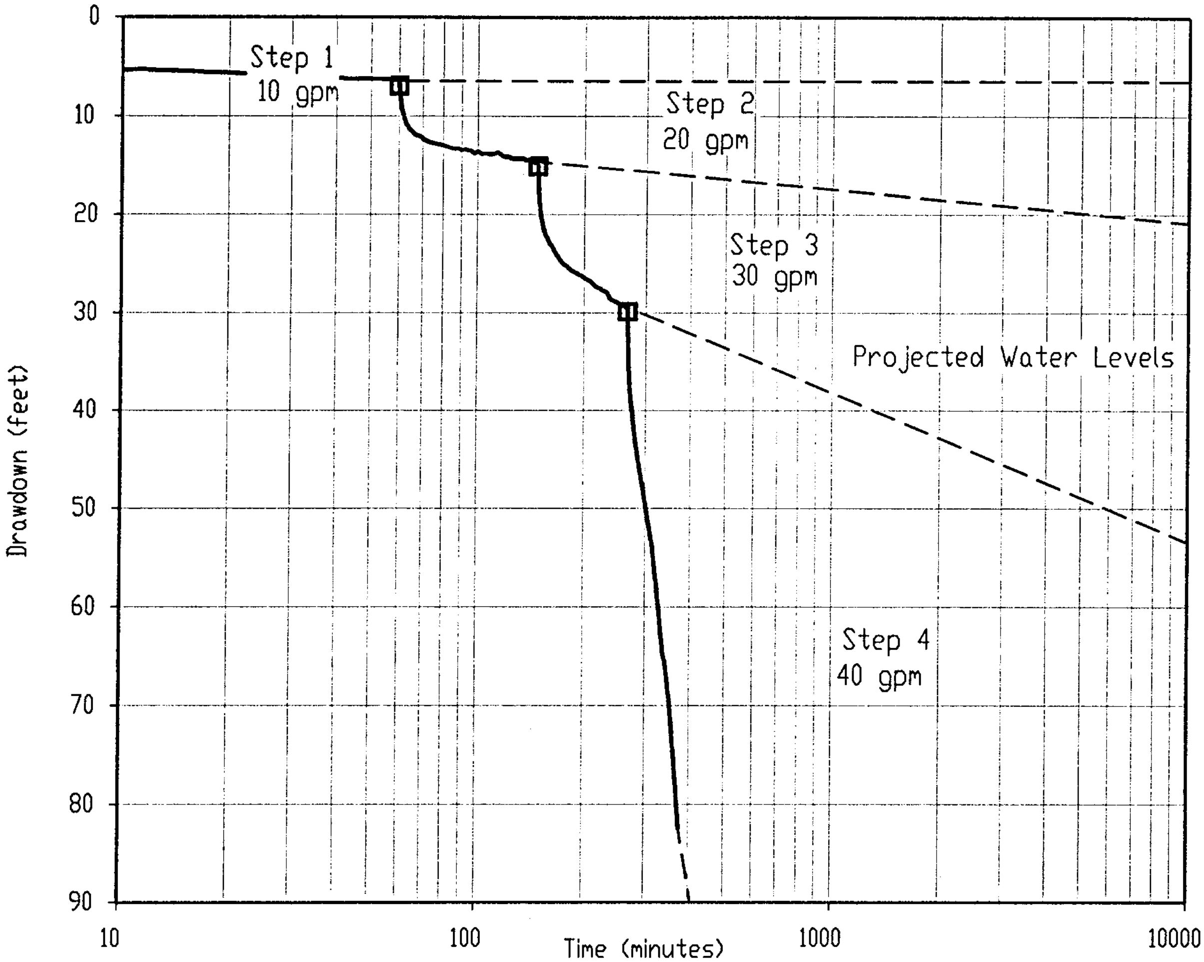
Water-level data from the extraction well will be plotted on semilog graphs during the tests to assure that each step has stabilized and can be interpreted (i.e., the straight line section on the semilog graph can be extrapolated) before proceeding the next step. Although water levels from monitoring wells are not required to interpret step tests, they may be recorded periodically to gauge monitoring well response in preparation for the constant-rate tests. An example plot is provided as Figure 4-3.

The wells should not be pumped dry during the step tests. However, sometimes unanticipated site conditions require the test to be terminated prior to proposed test completion. If data collected to that point is not sufficient to select a pumping rate for the constant-rate test, the step-test will be restarted after water levels have returned to pretest levels.

4.3.5 Constant Rate Testing

Constant-rate tests will be performed on wells 16GE1 and 16MPE1. Each test will be a standard constant-rate aquifer test of approximately 2 days duration. This initial duration was selected based upon the results of aquifer tests conducted at other sites at MCAS El Toro. However, if test data at the conclusion of 2 days is not sufficient to interpret the test (e.g., unexpected aquifer conditions occur), then the duration of the test may be extended. The constant pumping rate for each well will be selected based on the step-test data. The constant-rate test data will be used to estimate aquifer properties and radius of influence.

Water levels for each test will be measured in as many monitoring wells as necessary, in addition to the extraction well, to interpret the test and provide the required data. For the test in well 16GE1, water levels in monitoring wells MW4, MW5, and MW6 will be measured using transducers. For the test in well 16MPE1, water levels in monitoring wells 16MW1, MW6, MW7 and 16_DBMW52 will be measured using transducers, and well MW5 will be measured manually. These are considered to be the minimum wells



LEGEND

DRAWDOWN

STEP

PROJECTED DRAWDOWN

OU-3 Site 16 Pilot Study Work Plan

Figure 4-3

Generalized Drawdown From a Step-Extraction Test

MCAS, El Toro, California

Bechtel National, Inc.
CLEAN II Program

Date: 5/18/00
File No: 178C5212
Job No: 22214-178
Rev No: B

necessary to interpret the test. During the early portions of the tests, wells not initially in the test monitoring network will be checked as appropriate to evaluate their response to pumping. If a response is indicated in a given well, that well may be added to the test monitoring network.

4.3.6 Groundwater Treatment and Disposal

After passing through the groundwater GAC treatment system (Section 4.3.1.5), the treated groundwater produced from the extraction wells will be stored in 22,000-gallon storage tanks (or smaller multiple tanks). Subsequently, treated groundwater will be discharged into Bee Canyon Wash via a storm drain located on-site. Although a National Pollution Discharge Elimination System (NPDES) permit will not be required, the discharge of treated water will meet the substantive requirements of a NPDES permit.

4.4 SOIL VAPOR EXTRACTION SYSTEM

This section describes equipment requirements, test preparation requirements, and procedures for the soil vapor extraction (SVE) system. The SVE system will be used to extract soil vapors from 16MPE1 during an initial baseline 24-hour SVE test. The SVE equipment and procedures will then be used in conjunction with the preceding groundwater extraction equipment and procedures for the MPE test.

4.4.1 SVE System Equipment Requirements

General equipment and operation specifications required for the SVE system are described below. This list does not include all equipment necessary to complete the SVE portion of the testing. Equipment will be specified during premobilization activities and is subject to change based on field conditions.

4.4.1.1 VACUUM BLOWER

The vacuum blower specifications should allow for extraction rates of approximately 50 to 100 standard cubic feet per minute of soil air at 100 to 150 inches water gauge static pressure. The maximum negative pressure, or vacuum, developed by the blower should be approximately 200 inches water gauge. The blower will include a vacuum gauge on the inlet side, a pressure gauge on the discharge side, a temperature indicator, and an ambient air valve which will be used to control the vapor extraction rate from the well.

4.4.1.2 KNOCKOUT DRUM

The knockout drum is installed upstream of the vacuum blower to separate water droplets entrained in soil air. The volume of the drum should be a minimum of approximately 20 gallons. The drum is typically provided with a high-water-level switch that will shut down the blower if water collects in the drum above the set point. A valve is included on the drum to drain the separated water. Drained water will be transferred to the on-site groundwater extraction treatment system (Figure 4-2).

4.4.1.3 VACUUM MONITORING

Vacuum will be measured at the extraction and vapor monitoring wells using Magnehelic vacuum gauges. Gauges capable of measuring a wide range of negative pressures will be available. A gauge with the appropriate scale for each well response will be used. In addition to the vacuum gauges, two absolute pressure transducers will be placed in the extraction well to monitor the vacuum applied at the well and to monitor groundwater response to the applied vacuum.

4.4.1.4 FLOWMETERS

Vapor flow from the well will be monitored using a variable-area rotometer or other appropriate flowmeter. The rotometer will be capable of providing accurate discharge measurements, and will be sized appropriately to avoid restricting the flow, which could result in an artificially low flow from the well.

4.4.1.5 AIR POLLUTION CONTROL

A portable (trailer- or skid-mounted) SVE and vapor treatment system provided by a vendor is proposed to be used for the testing. This portable rental system will include the blower and knock out drum previously described, along with a particulate filter and two vapor GAC canisters (in series) appropriately sized for the site conditions. It is assumed that two 1,000-pound vapor GAC canisters will be sufficient. The system will be capable of reducing VOC concentrations to the below the levels required by the air discharge permit. The South Coast Air Quality Management District (SCAQMD) air discharge permit (typically, a various-locations permit for a rental system) shall be provided by the treatment system vendor. Vapor sample ports will be installed at the required locations for influent and effluent sampling.

4.4.1.6 POWER SUPPLY

Prior to mobilization of the SVE treatment system, the power supply adjacent to Site 16 will be evaluated for its compatibility with the vacuum blower. A common power requirement for a blower is 460V three-phase power. If the on-site power supply is insufficient to run the vacuum blower or requires extensive modification, it is assumed that a portable generator will be provided by the vendor, and that the vendor will maintain and refuel the generator.

4.4.2 SVE SYSTEM PREPARATION

The following preparation is needed before the start of the initial baseline SVE test and the subsequent MPE test.

4.4.2.1 HARDWARE SETUP

Before connection to 16MPE1, the vacuum blower will be connected to the power supply and run for approximately 30 minutes (or as deemed necessary) to check for excessive vibration, proper alignment, excessive noise level, and correct operation. After completion of checking operations, the blower will be shut down and piped to 16MPE1.

Prior to piping the blower to 16MPE1, a sealed wellhead manifold will be constructed that will allow vapor extraction at the wellhead while simultaneously pumping groundwater (for the subsequent MPE test). This manifold will be carefully sealed to the wellhead riser and to any other downhole equipment (e.g., pump piping, water-level monitoring equipment) to prevent ambient air leaks during SVE operation. Flowmeters within the expected range of vapor flow and a vacuum manual monitoring port will be installed. A sealed slip cap with a quick-connect coupling or stopcock valve (for the Magnehelic gauge) will be installed on each of the monitoring wells to be monitored for negative pressure. A silicone gel or an equivalent inert sealer will be used to form a tight seal between the manifold/slip caps and the wells.

Absolute pressure transducers will be installed in 16MPE1. One transducer will be suspended in the airspace of the well, and one will be submerged in the groundwater. The transducers will be connected to the data logger, and will be checked for proper operation prior to starting the testing.

4.4.2.2 RECORD BAROMETRIC PRESSURE

Barometric pressure will be recorded before, during, and after each test using a barometric pressure transducer, as described in the section on aquifer test preparation. A barometer may also be used for manual measurements.

4.4.3 General SVE System Testing Procedures

This section describes the SVE system general testing procedures to be used for the SVE and MPE testing. During SVE, when water levels are not drawn down via pumping, care must be taken to avoid drawing water in the extraction well above the top of the well screen under vacuum, which would cause soil airflow to cease. The following information will be recorded during the SVE testing:

- negative pressure (vacuum) in extraction and monitoring wells,
- soil gas extraction rate,
- concentration of VOCs in the soil gas,
- water produced in "knockout" system.

Flow data will be collected under negative pressures (vacuum) ranging from an estimated 20 inches to 150 inches (or greater) water gauge static pressure in the vapor extraction well. The maximum operating vacuum will depend on site conditions and will also be determined by the temperature at the blower discharge. A valve on the blower inlet line that is open to ambient air will be used to control the vacuum in the extraction well. Flow measurements will be recorded at the same frequency as the negative pressure measurements.

The negative pressures in extraction and monitoring wells will be measured manually at the wellheads and recorded at 15-minute intervals until steady conditions are achieved. After that point, vacuum will be measured twice a day. The transducer in the extraction well may be programmed for more frequent measurements. The barometric pressure at the site will be also recorded at regular intervals throughout the tests using the data logger.

Soil gas samples will be collected for field screening and laboratory analysis. Sample collection and laboratory analysis are described in Section 4.8. Organic vapor concentrations from the extraction well (16MPE1) will be measured daily in the field using a portable photoionization detector (PID) calibrated to isobutylene and a flame ionization detector (FID) calibrated to methane. In addition, to control carbon-adsorption breakthrough the VOC concentrations in the treated air will be measured in the GAC canister effluent using the portable PID. After completion of the test, the unit will be shut down and the knockout drum will be drained, if necessary. The volume of the drained water will be measured and placed in drums pending treatment at the on-site groundwater treatment system. If the blower is shut down by the high-water-level switch, the knockout drum will be drained and the unit will be restarted.

4.4.4 Initial Baseline SVE Test Procedures

The initial 24-hour SVE test will be conducted immediately prior to the MPE test. The procedures described below are to be performed subsequent to the SVE test preparation (Section 4.5.2). The SVE test is proposed to be conducted at three successively higher vacuum settings to evaluate a range of negative pressures and resulting flow rates of 16MPE1. Details on soil gas sampling and analysis are presented in Section 4.8. The following list outlines the procedures for the initial 24-hour SVE test.

1. Initially measure and record the depth to water and time of measurement in the following wells: 16MPE1, 16MW1, 16MW6, 16MW7, and 16MW5 (Figure 3-1).
2. Equip wells 16MV1, 16MW6, 16MW7, and 16MW1, and 16MW5 with a sealed slip cap and sealable vacuum measuring point
3. Prior to start-up, collect initial condition soil vapor samples from MPE1, 16MV1, 16MW1, 16MW6, and 16MW7 for laboratory analysis to assess ambient conditions before testing.
4. Energize vacuum blower and adjust vacuum to approximately 20 inches water at the wellhead. If this vacuum does not result in a measurable flow, the vacuum will be increased.
5. Record airflow, wellhead vacuum, discharge pressure, and operating temperature.
6. Collect test start-up influent and effluent soil gas samples from 16MPE1 as described in Section 4.8 for laboratory analysis to assess initial test soil gas concentrations. Collect samples from the well and GAC effluent to be used for PID measurements in the field.

7. Record vacuum using 0- to 1-inch water gauge Magnehelic gauges (or larger scale gauge if needed) in the monitoring wells at approximate 15-minute intervals until steady-state conditions are observed.
8. Increase vacuum to 60 inches water gauge at wellhead (or as directed by the project hydrogeologist).
9. Repeat steps 5 and 7. Collect soil vapor sample from well at appropriate time during middle of test.
10. Once steady-state conditions are observed, increase vacuum to maximum obtainable. However, the vacuum in inches of water should not be greater than the length of screen that was initially above the water table before the test began. If the vacuum exceeds this screen length, airflow would cease.
11. Repeat steps 5 and 7.
12. Immediately before the end of the test, collect influent and effluent soil gas samples from 16MPE1 for laboratory analysis to assess final SVE test soil gas concentrations. Collect samples from the well and GAC effluent to be used for PID measurements in the field.
13. Repeat step 1 immediately before the end of the test.
14. Depending on test results, at the end of the SVE test the MPE test may be initiated by starting the groundwater pump while the SVE system is still running. If not, de-energize the SVE system.
15. Drain knockout pot, if necessary.

4.4.5 Process Control

During the pilot tests, the field crew will control the vapor extraction rate and record the operating parameters and measurements in the field logbook. The parameters that will be measured and the minimum frequency that they will be recorded are listed in Table 4-2.

4.5 MPE PILOT TESTING

Following successful completion of the constant rate groundwater extraction and initial baseline SVE testing at 16MPE1, an MPE test will be conducted at 16MPE1.

4.5.1 General MPE Testing Procedures

The MPE test will consist of performing SVE in conjunction with groundwater pumping at 16MPE1, using the procedures for aquifer testing and SVE testing indicated in the previous sections. The rate of groundwater extraction and the soil vapor flow rate will be determined by the project hydrogeologist utilizing data from the aquifer pumping test and the response of 16MPE1 to an applied vacuum. The MPE test will initially be performed at constant groundwater pumping and airflow rates for the same duration (at a minimum) as the constant-rate aquifer test in 16MPE1. However, after that duration has been

Table 4-2
SVE System Operating Parameter Measurements

Parameter	Method	Frequency	Remarks
Meteorological Conditions			
Barometric pressure	Barometer	15 minutes until steady state; twice daily thereafter[a]	From field measurement; also via barometric transducer and data logger
Temperature	Thermometer	Daily	From field measurement
Vacuum Blower			
Inlet pressure	Vacuum gauge	Daily or when pressure is adjusted	
Inlet temperature	Temperature indicator	Daily or when pressure is adjusted	
Flow rate	Flowmeter	15 minutes until steady state; twice-daily thereafter	
Discharge pressure	Pressure gauge	Daily or when pressure is adjusted	
Discharge temperature	Temperature indicator	Daily or when pressure is adjusted	
GAC effluent[b]	PID/FID	Daily or when pressure is adjusted	
Water in knockout drum	Draining	As needed	
Vapor Extraction Well			
Pressure	Field vacuum gauge	15 minutes until steady state; twice-daily thereafter	During the MPE test, pressure measured via pressure transducer in the well airspace
VOCs	PID/FID	Daily	VOC analysis will also be performed as indicated on Tables 4-6 and 4-7
Monitoring Wells			
Pressure	Field vacuum gauge	15 minutes until steady state; twice-daily thereafter	
Groundwater level	Water-level probe	Daily[c]	During the MPE test, water levels will be measured via pressure transducers at the aquifer test frequency

(table continues)

Table 4-2 (continued)

Notes:
[a] barometric pressure will be measured at the same frequency as vacuum at the wells
[b] effluent from the first GAC canister will be measured each time the effluent of the second GAC canister is measured
[c] for the 24-hour initial SVE test, the daily water levels will be once at start-up and once just before shutdown

Acronym/Abbreviation:
FID – flame ionization detector
GAC – granular activated carbon
MPE – multiphase extraction
PID – photoionization detector
SVE – soil vapor extraction
VOC – volatile organic compound

reached, the pumping and airflow rates may be varied in order to evaluate potential maximum well yield under MPE conditions, and to optimize MPE operation. The maximum duration of the MPE testing is estimated to be 2 weeks.

Well monitoring will be a combination of the vacuum and water level monitoring points discussed in the previous sections. Vacuum monitoring will be conducted on the same wells and at the same frequency as described in the Initial Baseline SVE Test Procedures. The two absolute pressure transducers installed in 16MVE1 will remain in place for the MPE test. Water levels will be measured in monitoring wells 16MW1, 16MW6, 16MW7 and 16_DBMW52 using transducers, and well 16MW5 will be measured manually. This is the same network proposed for monitoring during the aquifer test. Pressure transducer measurements will be conducted at the same frequency as indicated for the aquifer test. This monitoring network may be modified during the MPE test, based on responses observed during the test. PID measurements of SVE treatment system effluent will be performed as indicated in Table 4-2. Groundwater and soil gas sampling for laboratory analysis will be conducted as described in the next Sections 4.7 and 4.8.

4.5.2 Summary of MPE Start-Up and Operating Procedures

The MPE pilot test is proposed to be operated at the maximum vacuum obtained during the initial baseline SVE test, and at the same pumping rate as used for the aquifer test. As mentioned previously, these rates may be modified later in the test to further evaluate MPE. The following list outlines the procedures that will be followed during the MPE pilot test operation.

1. Immediately prior to test start-up, measure and record the initial depth to water and time of measurement in all wells at Site 16 (Figure 3-1). Record barometric pressure.
2. If the vacuum blower is still running from the SVE test, shut off blower. Start the groundwater pump (adjust pumping rate to the same constant rate used during the aquifer test) and data logger. After the groundwater extraction rate

in 16MPE1 has stabilized, energize the vacuum blower and adjust vacuum in a step-wise manner to the vacuum chosen during the SVE test.

3. Record initial vacuum in 16MPE1 and in the monitoring wells and air flow, discharge pressure, and operating temperature.
4. Manually measure water levels (following the frequency in Table 4-1) in the MPE test monitoring well designated for manual monitoring.
5. Collect initial soil gas and groundwater samples from 16MPE1 and the treatment systems (if required). Also collect initial groundwater samples from the designated upgradient and downgradient wells.
6. Periodically measure and record water levels manually during the test in wells with transducers to check the transducer readings.
7. Record PID/FID measurements from the influent side of the SVE system and the effluent side of the carbon canisters daily.
8. Record airflow, vacuum at wellhead and monitoring wells, discharge pressure, and operating temperature throughout the test at the frequency of measurements indicated on Table 4-2.
9. After the first 2 days of operation (or the equivalent duration of the aquifer test), evaluate test progress and consider modifying the soil vapor and groundwater extraction rates to optimize the MPE system, if appropriate. Reevaluate test progress periodically during the test and make adjustments if appropriate.
10. After the first 7 days of operation, collect soil gas and groundwater samples from 16MPE1 and the treatment systems and collect groundwater samples from the designated upgradient and downgradient wells.
11. On the last day of the test, repeat step 10 for sampling.
12. Take final vacuum measurements in the designated wells, and water level measurements in all Site 16 wells.
13. Shut down the MPE pilot test system after approval of project manager (estimated to be approximately 14 days). The data logger should be restarted to record recovery of water levels.
14. Drain knockout pot and demobilize equipment. Remove pump from 16MPE1 only after instructed by the project manager.

4.6 SUMMARY OF TEST MONITORING

This section summarizes the wells to be monitored for the aquifer, SVE, and MPE pilot tests as described in the previous sections. Table 4-3 presents the wells that are considered to be necessary for monitoring to meet the objectives of each test. The well monitoring networks are subject to modification based on field conditions.

Table 4-3
Summary of Wells to Be Monitored for the Pilot Testing

Test	Wells Monitored	Parameter	Method	Frequency
All tests	Background well[a]	Water levels	Water-level meter	Daily during entire pilot testing period
16GE1 aquifer step test	16GE1	Water levels	Transducer	See Table 4-1; restart for each step
16GE1 constant-rate aquifer test	16GE1, 16MW4, 16MW5, 16MW6	Water levels	Transducers	See Table 4-1; restart at recovery phase
16MPE1 aquifer step test	16MPE1	Water levels	Transducer	See Table 4-1; restart for each step
16MPE1 constant-rate aquifer test	16MPE1, 16MW1, 16MW6, 16MW7, 16_DBMW52	Water levels	Transducers	See Table 4-1; restart at recovery phase
	16MW5	Water levels	Water-level meter	See Table 4-1; restart at recovery phase
16MPE1 initial SVE test	16MW1, 16MW6, 16MW7, and 16MW5	Water levels and vacuum	Water-level meter[b] and Magnehelic gauges	Water levels: prior to test startup and shutdown Vacuum: 15 min. until stabilized; then twice daily
	16MPE1	Water levels and vacuum	Absolute pressure transducers (2)[c] and Magnehelic gauge	15 min. until stabilized; then twice daily[d]
	16MV1	Vacuum	Magnehelic gauge	15 min. until stabilized; then twice daily
16MPE1 MPE test	16MW1, 16MW6, 16MW7	Water levels and vacuum	Transducers and Magnehelic gauges	Water levels: See Table 4-1 Vacuum: 15 min. until stabilized; then twice daily
	16MPE1	Water levels and vacuum	Absolute pressure transducers (2)[c] and Magnehelic gauges	Water levels: See Table 4-1 Vacuum: 15 min. until stabilized; then twice daily
	16_DBMW52	Water levels	Transducer	See Table 4-1
	16MW5	Water levels and vacuum	Water-level meter and Magnehelic gauge	Water levels: See Table 4-1 Vacuum: 15 min. until stabilized; then twice daily
	16MV1	Vacuum	Magnehelic gauge	15 min. until stabilized; then twice daily

(table continues)

Table 4-3 (continued)

Notes:
[a] background well outside the pumping area of influence to be determined
[b] Since the transducers may already be installed in three of these monitoring wells from the aquifer tests, transducers may be used to record water levels at a frequency equivalent to 16MPE1
[c] one transducer will be suspended in the air space a few feet below the surface, and one transducer will be submerged near the bottom of the well
[d] the frequency is a minimum requirement; more frequent monitoring may be programmed into the data logger

Acronyms/Abbreviations:
MPE –multiphase extraction
SVE – soil vapor extraction

4.7 GROUNDWATER SAMPLING

Groundwater sampling will be conducted prior to starting the first test, during the pilot testing, and following pilot testing completion. Analytes to be tested include VOCs, SVOCs, TPH, and various treatability parameters. The treatability parameters were selected based on EPA guidelines for conducting treatability studies under CERCLA (U.S. EPA 1992a) and U.S. Army Corps of Engineers guidelines contained in the MPE engineering manual (U.S. Army Corps of Engineers 1999), with consideration for the applicability of individual parameters to Site 16 conditions and test objectives. Table 4-4 summarizes the groundwater sampling program for the MPE pilot testing. Table 4-5 summarizes the analysis, sample type and purpose of the required samples.

Groundwater sampling procedures and quality control are described in detail in the FSP (Appendix A), and in CLEAN SOP 8. For each well, a groundwater sample will be collected after the well has been purged and temperature, pH, and specific conductance have stabilized to within 10 percent of previous measurements. For new wells, groundwater samples will be collected after waiting at least 48 hours following completion of well development. Samples of groundwater from the treatment system will be collected from a sample port valve while the treatment system is operating. In addition to samples collected for treatment system parameters, VOC samples will be collected from between (midfluent) and after (effluent) the GAC canisters on an as-needed basis in order to prevent potential carbon breakthrough from occurring the test.

4.8 SOIL GAS SAMPLING

Soil gas sampling will be conducted prior to starting the SVE test to establish initial VOC concentrations in soil, during the tests to track the effects of the pilot testing on VOC concentrations, and after completion of the tests to evaluate final VOC concentrations. Soil gas samples will also be collected to comply with SCAQMD air emissions discharge requirements. Table 4-6 summarizes the soil gas sampling program for the MPE pilot testing. Table 4-7 summarizes the analysis, sample type and purpose of the required samples. Additional tests may be required to comply with the SCAQMD air discharge permit.

Soil gas sampling procedures and quality control are summarized in Section 5.4 of the FSP (Attachment A). The sampling procedure shall be in compliance with all applicable rules and regulations. The soil gas samples will be collected in Tedlar™ bags. In addition to soil gas samples collected for laboratory analysis, samples will be collected for field screening by a PID.

Table 4-4
Summary of Groundwater Sampling Program

Test	Sample Location	Analyte(s)	Frequency	Total Samples
Wells:				
Pretest initial sampling	All groundwater wells at Site 16	VOCs, SVOCs, TPH	Once (initial sampling)	10
Constant-rate aquifer tests	Extraction wells	VOCs	Beginning and end of test	4[a]
MPE test	Extraction well	VOCs	Once a day first week, three samples thereafter, and end of test	9
Posttest final sampling	All groundwater wells at Site 16	VOCs, SVOCs, TPH	Once (after completion of all tests)	10
Treatment System				
Constant-rate tests	Influent to and effluent from GAC canisters	Treatment parameters,[b] VOCs	End of test[c]	4[a]
MPE test	Influent to and effluent from GAC canisters	Treatment parameters,[b] VOCs	End of test[c]	2
Constant-rate and MPE tests	Midfluent between the GAC canisters	VOCs	End of constant rate tests; beginning and end of MPE test; or as needed[d]	4

Notes:
[a] two samples collected per test
[b] treatment parameters include biochemical oxygen demand, chemical oxygen demand, alkalinity, total dissolved solids, total suspended solids, total organic carbon, calcium, magnesium, manganese, sodium, potassium, iron, and hardness (refer to Table 4-5 for details)
[c] additional samples may be collected as needed for VOC analysis only to monitor carbon breakthrough of the second GAC canister
[d] midfluent samples are collected primarily to monitor carbon breakthrough of the first GAC canister; the number of samples is estimated; additional samples may be analyzed as needed

Acronyms/Abbreviations:
GAC – granular activated carbon
MPE – multiphase extraction
SVOC – semivolatile organic compound
TPH – total petroleum hydrocarbons
VOC – volatile organic compound

Table 4-5
Groundwater Sample Analysis, Sample Type, and Purpose

Chemical Parameter	Chemical Analysis	Container	Purpose of Analysis
Wells			
VOCs	U.S. EPA Method 8021B	Three 40-mL VOA vials; pH <2 with HCl; no headspace cool, 4°C	To evaluate concentrations of VOCs in groundwater to estimate mass, mass removal, and treatment requirements.
SVOCs	U.S. EPA Method 8270	Two 1-liter amber glass bottles; cool, 4°C	To evaluate concentrations of SVOCs in groundwater (if present).
TPH	U.S. EPA Method 8015M	Two 1-liter amber glass bottle; pH <2 with HCl cool, 4°C	To evaluate concentrations of petroleum hydrocarbons in groundwater (if present).
Treatment parameters			
BOD	U.S. EPA Method 405.1	Liter polyethylene bottle; no headspace; cool, 4°C	To indicate the quantity of biologically oxidizable material (i.e. electron donors) present; to assess if the BOD level in extracted water will meet discharge requirements, if any.
COD	U.S. EPA Method 410	125-mL polyethylene; pH <2 with HCl or H_2SO_4; cool, 4°C	To indicate the quantity of chemically oxidizable material present; to assess if the availability of electron donors.
Alkalinity	U.S. EPA Method 310.1	250-mL polyethylene bottle; cool, 4°C	To assess whether conditions are too acidic or alkaline to support abundant microbial populations and whether or not carbon dioxide will be generated as a result of aerobic degradation
TDS	U.S. EPA Method 160.1	250-mL polyethylene bottle; cool, 4°C	To assess salinity
TSS	U.S. EPA Method 160.2	250-mL polyethylene bottle; cool, 4°C	To assess the amount of solids in the extracted groundwater for treatment requirements
TOC	U.S. EPA Method 415.1	40-mL amber vial; pH <2 with H_2SO_4; cool, 4°C	To indicate the ability of organic compounds to partition to the solid or aqueous phases; may be used to assess availability of electron donors
Iron	U.S. EPA Method 6010B	Liter polyethylene bottle; pH <2 with HNO_3; cool, 4°C	To indicate the presence of either reductive or oxidative conditions and to indicate need for treatment of iron in extracted groundwater; ferrous iron may be used to assess whether ferric iron is being used as an electron acceptor

(table continues)

Table 4-5 (continued)

Chemical Parameter	Chemical Analysis	Container	Purpose of Analysis
Calcium, magnesium, manganese, sodium, potassium	U.S. EPA Method 6010B	Liter polyethylene bottle; pH <2 with HNO_3; cool, 4°C	To indicate the presence of cations/anions which could precipitate in any treatment process
Hardness	U.S. EPA Method 130.1	250-mL polyethylene bottle; pH <2 with HNO_3; cool, 4°C	To indicate alkalinity and tendency for scale formation

Acronyms/Abbreviations:
- ASTM – American Society of Testing and Materials
- BOD – biological oxygen demand
- COD – chemical oxygen demand
- HCL – hydrochloric acid
- HNO_3 – nitric acid
- H_2SO_4 – sulfuric acid
- SVOC – semivolatile organic compound
- TDS – total dissolved solids
- TOC – total organic carbon
- TPH – total petroleum hydrocarbons (gasoline and diesel)
- TSS – total suspended solids
- U.S. EPA – United States Environmental Protection Agency
- VOA – volatile organics analysis
- VOC – volatile organic compound

Table 4-6
Summary of Soil Gas Sampling Program

Test	Sample Location	Analyte(s)	Frequency	Total Samples
Wells				
Pretest initial sampling	16MPE1, 16MV1, 16MW1, 16MW6, 16MW7	VOCs, fixed gases	Once (initial sampling); fixed gases from 16MPE1 only	5
Baseline SVE test	MPE1	VOCs	Beginning, middle, and end of test	3
MPE test	MPE1	VOCs	Beginning, middle, and end of test	10
Posttest sampling	16MPE1, 16MV1, 16MW1, 16MW6, 16MW7	VOCs, fixed gases	Once (final sampling); fixed gases from 16MPE1 only	5
Treatment System				
Baseline SVE test	Effluent from VGAC canisters	VOCs	Beginning and end of test[a]	2
MPE test	Effluent from VGAC canisters	VOCs	Beginning, middle, and end of test[a]	3
SVE and MPE tests	Midfluent between the VGAC canisters	VOCs	End of SVE test, middle and end of MPE test, or as needed[b]	3

Notes:
[a] additional samples may be collected as needed to monitor carbon breakthrough of the second GAC canister
[b] midfluent samples are collected primarily to monitor carbon breakthrough of the first GAC canister. The number of samples is estimated; additional samples may be analyzed on an as-needed basis

Acronyms/Abbreviations:
MPE – multiphase extraction
SVE – soil vapor extraction
VOC – volatile organic compound

Table 4-7
Soil Gas Sample Analysis, Sample Type, and Purpose

Chemical Parameter	Chemical Analysis	Container	Purpose of Analysis
VOCs	U.S. EPA Method 8021B	Tedlar bag	To evaluate concentrations of VOCs in soil gas to estimate mass, mass removal, and treatment requirements
Methane & fixed gases	ASTM D-1945	Tedlar bag	To evaluate concentrations of methane and fixed gases in soil gas to assess biological activity in the vadose zone

Acronyms/Abbreviations:
U.S. EPA – Environmental Protection Agency
VOC – volatile organic compound

Section 5
DATA EVALUATION

The pilot study data will be analyzed to fulfill the MPE pilot study objectives (Section 4). The implementability of a full-scale MPE system will also be evaluated from the pilot-test results.

5.1 EVALUATION OF THE SVE TEST

Evaluation of SVE test results will include estimating the SVE ROI, the VOC concentrations prior to MPE, VOC mass removal rates, and optimal vapor extraction rates. The data evaluation methods below will also be used for the MPE test, and the baseline SVE test results will be compared to the MPE test results.

5.1.1 SVE Radius of Influence

The SVE ROI will be estimated using graphical and/or analytical methods, as appropriate. Graphical methods include plotting vacuum versus distance from the MPE well on a semilog graph. A best-fit straight line is then drawn through the data points and extrapolated to zero vacuum. Typically, a percentage of the vacuum extraction rate or a fixed value (e.g., 1/10-inch vacuum) is used to define the ROI. However, the effective zone of remediation may be less than the ROI because vacuum propagation and air velocity decrease substantially with distance from the extraction well (U.S. EPA 1992b). Therefore, vacuum propagation through the subsurface will also be evaluated to estimate an effective ROI. This effective ROI is estimated based on calculations of soil permeability to airflow and soil gas velocity (Johnson et al. 1990a,b), which account for various soil parameters, well construction, and recorded vapor flow rate and vacuum.

The MPE conceptual design presented in the draft FS Report estimated that one SVE well would be required to remediate VOCs in soil vapor beneath Site 16. This estimation will be reevaluated utilizing data collected during the pilot testing to assess whether more than one well is required. Methods to estimate the number of SVE wells necessary at a site include plotting the estimated zones of influence on maps that illustrate VOC extent in soil gas, dividing the total area of contaminated soil by the area of influence of one well, or dividing the total VOC mass in the vadose zone by the product of the mass removal rate in one well by the time required for remediation.

5.1.2 VOC Mass Removal Rate

The effectiveness of SVE to remove VOCs from the soil beneath Site 16 will be evaluated by estimating the VOC mass removal rate. The VOC mass removal rate will be estimated by multiplying the recorded vapor flow rate, time of operation, and the VOC concentrations obtained from the laboratory analyses of vapor samples collected from the extraction vapor stream. Once the mass removal rate is known, the time required to remove a given mass of VOCs can also be estimated. The amount of time required to remove a given amount of VOCs from the site is a measure of the effectiveness of SVE. The pilot test results and field observations will also be used to evaluate the implementability and cost of SVE/MPE at the site.

Continue

5.1.3 Vapor Extraction Rate

The multiple vapor extraction rates used during the initial SVE test will be used to choose an optimum flow rate for the MPE test by plotting flow rate versus vacuum. Vapor flow rates can be limited by the permeability of the formation, such that further increases in vacuum do not result in an increased flow rate.

5.2 EVALUATION OF THE AQUIFER TESTS

Aquifer testing will be evaluated by estimating aquifer characteristics (transmissivity, storativity, and specific capacity), well capture zone, and VOC removal rates. This evaluation will be used to assess the effectiveness of downgradient groundwater extraction in the VOC plume, and as a baseline for the MPE test. Aquifer characteristics will be used to estimate the capture zone of each extraction well. Estimates of aquifer characteristics can also be used to assist in the selection of additional well sites during remedial design.

5.2.1 Step-Drawdown Testing

Step-drawdown testing will be completed to measure the aquifer's response to induced stress through pumping. Step-drawdown data yield estimates for specific capacity and well efficiency and aid in the selection of the aquifer pumping rates for the constant rate tests.

5.2.1.1 SPECIFIC CAPACITY

The specific capacity of a well is its flow rate divided by the drawdown. Specific capacity data will be used to help select the flow rate for the constant-rate test.

5.2.1.2 WELL EFFICIENCY

Well efficiency is defined as the amount of drawdown predicted using the Theis method when compared with the actual drawdown in a pumping test well. Well efficiency is normally expressed as a percentage. Low well efficiency can be a result of poor well construction methods and development, and/or geologic conditions. Efficiency data can be used to refine the well construction and development. During remediation system design, optimizing the well efficiency may result in cost savings due to a reduction in the number of extraction wells required for remediation.

5.2.1.3 SELECTED PUMPING RATE FOR CONSTANT-RATE TEST

Aquifer step-testing will aid in the selection of the flow rate for constant-rate testing. It is important that each step is run long enough to extrapolate a terminal drawdown. The project hydrogeologist will plot the drawdown data on a semilog graph. The pumping rate chosen for the constant-rate test will typically be the pumping rate that is projected to provide the maximum drawdown for the proposed duration of the constant-rate test, but which will not draw the water level down to the pump intake. Figure 4-3 illustrates projected drawdown in a generalized step-drawdown test.